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# THE CLEANING AND HANDLING OF BARLEY[1]

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## INTRODUCTION

Since its re-establishment in 1933, the National Barley Committee and its collaborating agencies have renewed efforts to improve the quality of western Canadian barley, extend the markets, and thus make profitable an increased acreage. It has been found that in certain markets cleanliness and freedom from mechanical damage are among the prerequisites for increased sales. Accordingly, in August, 1934, the National Barley Committee appointed a Sub-Committee on Cleaning and Handling to investigate the adequacy and suitability of the methods and equipment now in use. For the most part, these have been developed primarily for merchandizing wheat and it was considered desirable that their application to barley should be investigated.

The main part of this investigation took the form of a survey. Samples of grain were collected after threshing and at each subsequent stage of marketing. Cleaners and cleaning systems were observed in country and terminal elevators, and in malt houses in Canada, the United States and the British Isles. Information was gathered from manufacturers of cleaning machinery on both sides of the Atlantic by personal visits and by correspondence.

While much of the knowledge gained by the survey has a general application, some of the conclusions must be considered as tentative since they are based on results which may be subject to seasonal variation. In order that conclusions of wider application might be drawn and to assist in the interpretation of the survey results, a number of laboratory experiments were conducted.

## CLEANING OF BARLEY

### Cleaning Devices

In order that grain may be cleaned, the material to be separated must differ from the grain in one or more of the following characteristics:

1. Length
2. Width
3. Shape
4. Weight
5. Specific gravity
6. Elasticity
7. Capacity for adherence.

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In this section the principal types of devices used to make the separations are discussed, and examples of their use in commercial cleaning machinery are given. These examples are drawn from observations and from information received during this investigation, and it should be distinctly understood that no attempt has been made to include all the cleaning machines on the market. Since no comparisons of the relative efficiency of different types or makes of machines have been made, the order in which they are listed has no significance and the omission of any make does not imply inferiority to those cited.

I. Screens

(1) *Sieves or riddles.* These may be made of wire or perforated metal, and the common openings are square, oblong, round, and triangular. The separations may be made on the basis of width, length or shape. The sieves may slope and vibrate longitudinally as in the Eureka, Invincible, Monitor, Globe, and machines of European manufacture such as the Boby or the Booth sifter. The Carter Company's Millerator has sloping sieves with a gyratory motion. In the Porteus Improved Barley Separator and in machines of the plansifter class the screens are horizontal and the motion gyratory.

In American practice sieves are generally used only for "roughing-out." In Europe, however, much greater dependence is placed on sieve separations.

(2) *Angle screens.* The openings in these screens are in the form of passages which turn at right angles. Short seeds can pass around the corners but long seeds are held back. The screen is set on a slant with the entrances of the passages pointing upward along the screen, and it is vibrated with a sharp jerking motion which causes the overs to move to the top. The oat kicker is a typical example. These machines are not used extensively in the cleaning of commercial barley.

(3) *Rotating screens.* This type is used in the scalper of the Superior cleaner. The grain flows between two slowly rotating vertical perforated discs. The grain passes through the perforations and the coarse material combs up to the tailings spout.

(4) *Cylindrical screens.* The grain may be fed either to the outside or inside of revolving cylindrical screens. The former plan is now widely used in scalping devices. The feed is at right angles to the long axis of a horizontal cylinder clothed with coarse wire mesh. The grain drops through while the scalpings which are too long or too wide to pass the mesh tail over. The Grade-Maker scalper employs a special form in which a revolving cylindrical screen is mounted vertically. The dirty grain is fed to the outside of the cylinder and the grain passes through while the scalpings are carried by friction to the tailings spout.

Where interior feeding is employed, the cylinders are generally set on a slight slope. They may be constructed with round-perforated screen as in the machines used for "roughing-out" in flour mills, or with long perforations parallel to the long axis of the cylinder, as in the small capacity Barley and Oat Grader made by Robinson and Sons. Most of the cylinder machines adapted to commercial cleaning of barley use special forms of screen of the following types:

*(a)* Ring graders. In this type rings, which are generally roughly triangular in cross section, are fastened together, spaced at suitable intervals, to form a cylinder. It is common practice to employ graduated spacing in each cylinder, the narrowest apertures being at the feed end. The separation is on the basis of width. The Rich Ring Grader is a typical example.

*(b)* Wire graders. These are similar in principle to the ring graders but are built up of wires fastened to a cylindrical frame. Wire graders are much more widely used for cleaning and grading barley in Europe than in America. Machines of this type are manufactured by Kipp-Kelly Ltd., Winnipeg, George Porteus and Sons, Leeds, and Robert Boby Ltd., Bury St. Edmunds.

*(c)* Wild-oat cylinders. These cylinders are made of woven wire corrugated lengthwise, giving the cross section of the cylinder the shape of a many-pointed star. As the cylinders rotate, these corrugations cause the oats to tip up and pass through the meshes. The separation is therefore on the basis of width. Machines of this type are sometimes used to reclean the screenings from commercial barley.

(5) *Needle screens.* Each screen consists of a row of steel needles about 4 to 6 inches long, set parallel to each other, fastened at the outer end and sloping inwards. Usually about forty screens are used in a single machine, set one above the other so that the grain moves in a zig-zag fashion by gravity from one unit to the next. The screenings are prevented from remixing with the grain by metal baffles. The separation is on the basis of width. The invincible Needle Screen Gravity Barley Separator is quite commonly used on this continent for cleaning barley and grading it according to size.

II. Pocket Devices

(1) *Indented belts.* These have indentations in their surface and may be made of either metal or rubber. They separate on the basis of length. Belts are generally used only on small capacity machines.

(2) *Indented cylinders.* These have pockets pressed or drilled into the inner surface of the cylinder. As the cylinder revolves, the material which fits these pockets is raised and dropped into a centrally located trough and is moved out of the machine by a screw conveyor or by gravity. The separation is on the basis of length. The barley may be lifted from the coarse material or the fine seeds may be lifted from the barley according to the size of pocket. This type of machine is widely used, both on this continent and in Europe. Cylinders are used in the following American machines: Emerson, Superior, Grade-Maker, Kipp-Kelly Trieur, Carter Combination. Indented cylinders are made in England by Robert Boby Ltd., and Thos. Robinson and Son, Ltd.

(3) *Discs.* The pockets are in the sides of metal discs, mounted in a group vertically on a shaft. The pockets on each disc are all the same size but discs with different sized pockets may be grouped on the same shaft. The material picked up by each disc is dropped into troughs on either side of it. As in indented cylinders, the separation is by length and the machines may be arranged to remove grain from coarse screenings or fine seeds from grain. Carter Disc machines are widely used for cleaning barley.

### III. Aspiration

Cleaning by aspiration is very widely used. Generally the air blast is applied in conjunction with some other device, as in most of the sieve machines and in many of the scalping units. However, special machines such as the Carter Duo-Aspirator, employing air separation only, may be used. The air may be either blown or sucked through a thin layer of grain, generally as it falls, or as it passes over a sieve. The basis of separation is rather complex. Whether or not any particle will be removed by an air stream of given velocity will be determined by its weight in relation to the area of the surface exposed to the force of the blast. Weight and shape are therefore the important factors. With particles of similar size and shape, separation will depend on differences in specific gravity.

### IV. Vibrating Tables

In their simplest form these consist of a plane oblong surface tipped slightly diagonally and vibrated longitudinally. The material to be separated is fed on to the table at the high corner. Spherical particles roll off directly from the spout while flat particles move across the table. Intermediate shapes move in paths between these. In the "Specific Gravity" separator, sold by the Kipp-Kelly Co., Winnipeg, the table is covered with perforated screen through which air is forced, and divided into straight channels by wooden strips. The exact design of table is governed by the material to be separated. The separation depends on shape and the other factors contributing to air separation. This type of machine is not, at present, used in commercial barley cleaning in Canada. In Europe, vibrating tables in which the channels are of zig-zag shape are in commercial use. The claim is made that the distance through which the particles bounce on hitting the channel walls, and which depends partly on the elasticity of the material, aids in the separation.

### V. Liquid Separation

When dirty grain is immersed in a liquid, particles of greater specific gravity than the liquid will sink, and those of lesser specific gravity will float. By using liquids of different densities it has been found possible to make the separations desired. This system is in commercial use for seed cleaning, and in an elementary form for the removal of stones from wheat, but not for the cleaning of feed or malting barley.

### VI. Spiral Gravity Separators

This type consists of a metal spiral chute dividing towards the bottom into a number of spouts. The grain is fed in at the top and, as it flows down the spiral, the round weed seeds move to the outer edge and are removed by a separate spout. Shape is the basis of separation. These machines have comparatively small capacity.

### VII. Cloth Separators

These separate seeds on the basis of the capacity for adherence. Wild oats may be separated from grain by this means because the awn will attach itself to flannel. The cloth may be arranged as a belt or as the lining of a drum. The use of silk belts for the separation of durum wheat from barley has been suggested.

## Cleaning Feed Barley

With modern cleaning machinery barley can be cleaned to any desired degree of purity. Barley practically free from wild oats and weed seeds can be produced in one cleaning. To attain this in one operation, however, a certain amount of barley must be allowed to go out with the oats and recleaning of the screenings is necessary to recover this. Efficient machinery is on the market and is already installed in many elevators. Whether such machinery is used is a matter of commercial expediency. In other words, it is a question of whether screenings can be disposed of more profitably as such, or as impurities in, and sold as, barley. The answer does not depend solely on the relative prices of screenings and barley. There is prospect of an appreciable increase in our barley production and markets must be found for this grain. To obtain these markets, we can compete either on a basis of price or of quality and it may be necessary to ship cleaner grain in order to expand our markets in certain areas.

The returns from the sale of screenings are also important and this raises the whole question of the disposal and processing of this material. It has been suggested that it might be advantageous to consider the erection of a special plant for handling screenings at the Head of the Lakes but it is very doubtful whether the time is ripe for the establishment of such a plant. Methods of disposal of screenings by individual elevators, however, are worthy of immediate attention. Among other things, inquiries might be instituted into (1) the market for wild oat groats—whole or ground (2) the market for ground feed prepared in pellet form.

An extended discussion of the commercial considerations is beyond the scope of this report, but it is evident that satisfactory answers to the questions raised in this section are vital to the development of our barley trade.

## Cleaning Malting Barley

There can be no doubt of the desirability of almost completely removing the impurities from barley before it is malted. While stock can eat wild oats and most weed seeds without any great harm being done, such impurities are useless for the production of malt and may even be a detriment to its sale, apart from the reduction in extract yield which results from their presence. Black wild oats in malt give it a most unattractive appearance.

On this continent, and particularly in Canada, the maltsters have very well equipped cleaning plants and they can, if necessary, remove any amount of impurities. However, all processers of grain feel that elaborate cleaning and the disposal of screenings is not their real business. Unless dirty grain can be purchased at a good discount they much prefer to buy reasonably clean grain.

The situation with regard to malting barley for export to Europe is slightly different. Malting plants in Europe do not have such elaborate cleaning facilities and consequently they are unable to remove all of the impurities commonly found in our exported barley. Moreover, they object to the large quantities of dust which inevitably arise when very dirty barley is cleaned. Their attitude towards the disposal of screenings is much the same as that of our Canadian maltsters. In order to hold our

present market, or to entertain any hope of extending it, it is imperative that we export our barley intended for malting, whether it grades 3 extra or 3 C.W., in a reasonable state of cleanliness.

It has been suggested that we should go a step further and export our malting barley graded as to size of kernel. It would appear, however, that at the present time there would be no advantage to this. A series of sized samples was shown to several maltsters in England and they expressed the opinion that for the preparation of diastatic malts, which are the mainstay of our present market in England, the large grade would be lacking in diastase and the small grade would be low in extract. In this connection it may be pointed out that the English practice is to do any sizing after malting rather than before. Six-row barley and two-row barley are, of course, malted separately.

### Cleaning Systems

In the previous section, reference was made to the difference between the cleaning systems employed by American and European maltsters. In order to illustrate this and to show the use of the different types of machine, examples of flow sheets of cleaning plants for the treatment of malting barley are given. These examples were obtained by inspection of cleaning machinery installed in malt-houses, from the recommendations of machinery manufacturers, and in a few cases from published flow-sheets.

*American Systems.* Examples of cleaning systems in use or recommended for use in malt-houses on this continent are given in Figures 1 to 11. It will be noticed that these systems combine cleaning and sizing, since it is the usual practice to separate the large and small kernels before malting. In general, the large kernels, being higher in extract, are used for brewer's malt, and the small kernels, being higher in diastase, are used for distiller's malt. The sizing tends to complicate the systems but at the same time it aids in obtaining a good separation of the impurities. Some of the systems are quite complex, and, at the other extreme, one small malt-house connected with a brewery was visited where the cleaning and sizing was accomplished with a single machine of the indented-cylinder type. This was a special case where a rather high loss of barley in the screenings was not of a great importance because of unusually favourable arrangements for their disposal.

No examples of terminal elevator systems have been included, since the use of only one machine is quite common. Where more than one type or make of machine is available, the choice is often dictated by considerations of convenience in general elevator operation. When necessary, of course, more than one machine may be used. The barley may be roughed-out in a machine of the sieve type and the cleaning finished with cylinder or disc machines. A few elevators have needle machines, and it is often found convenient to use them, partly because their operation does not require power, an important consideration, particularly in elevators using steam engines. Apart from the main cleaning operation, additional machines may be used for the recleaning of screenings in order to cut down the cleaning loss.

There is one important difference in the lay-out of cleaning plants in elevators and in malt-houses. In the former, the general arrangement is horizontal, and transfer of the grain from one machine to another involves

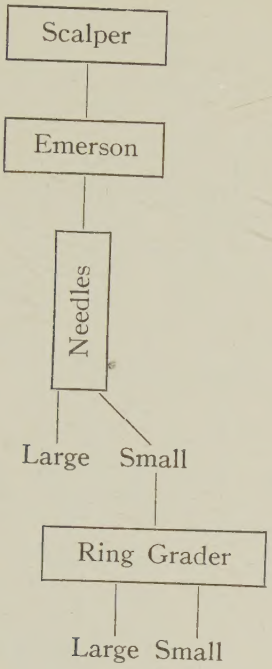
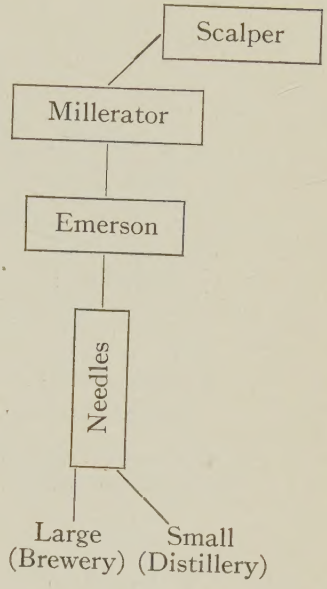



FIGURE 1

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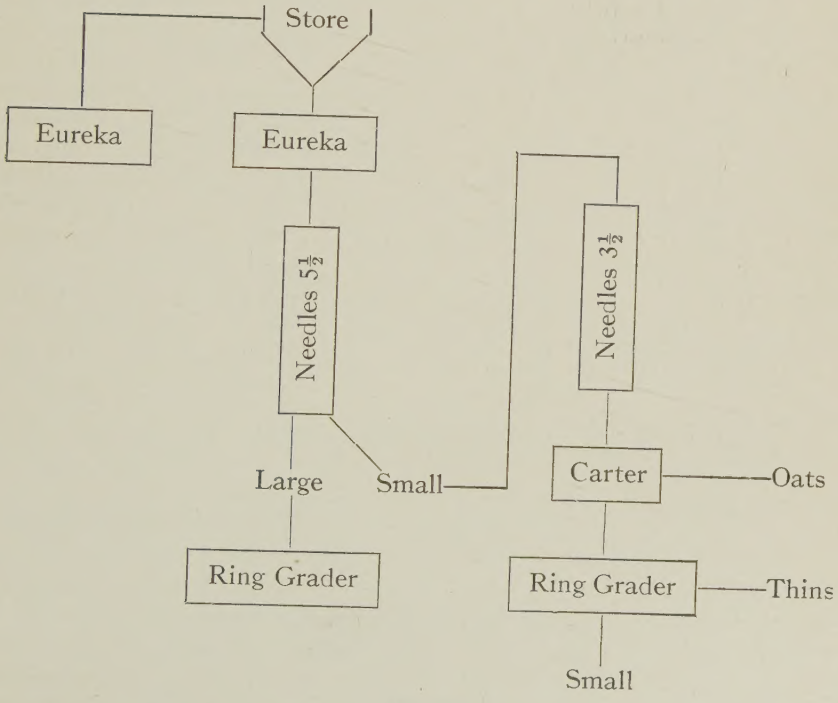



FIGURE 3

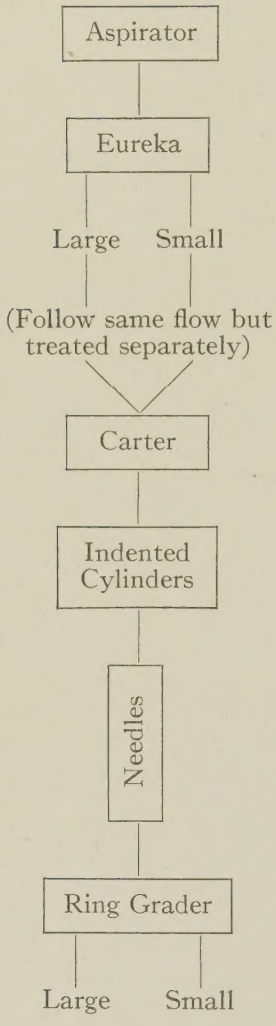



FIGURE 4

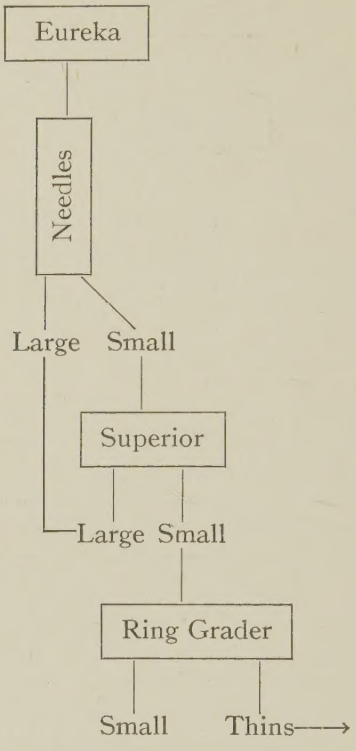



FIGURE 5

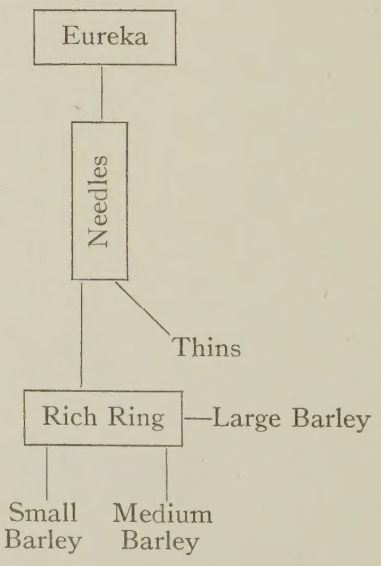



FIGURE 6

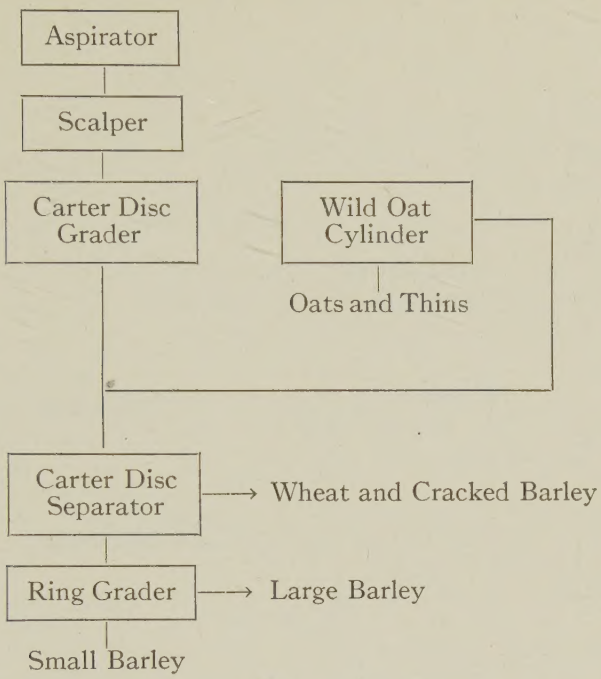



FIGURE 7

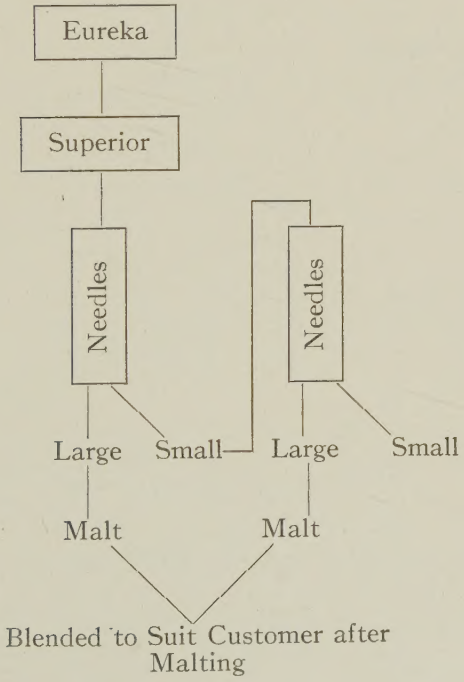



FIGURE 8

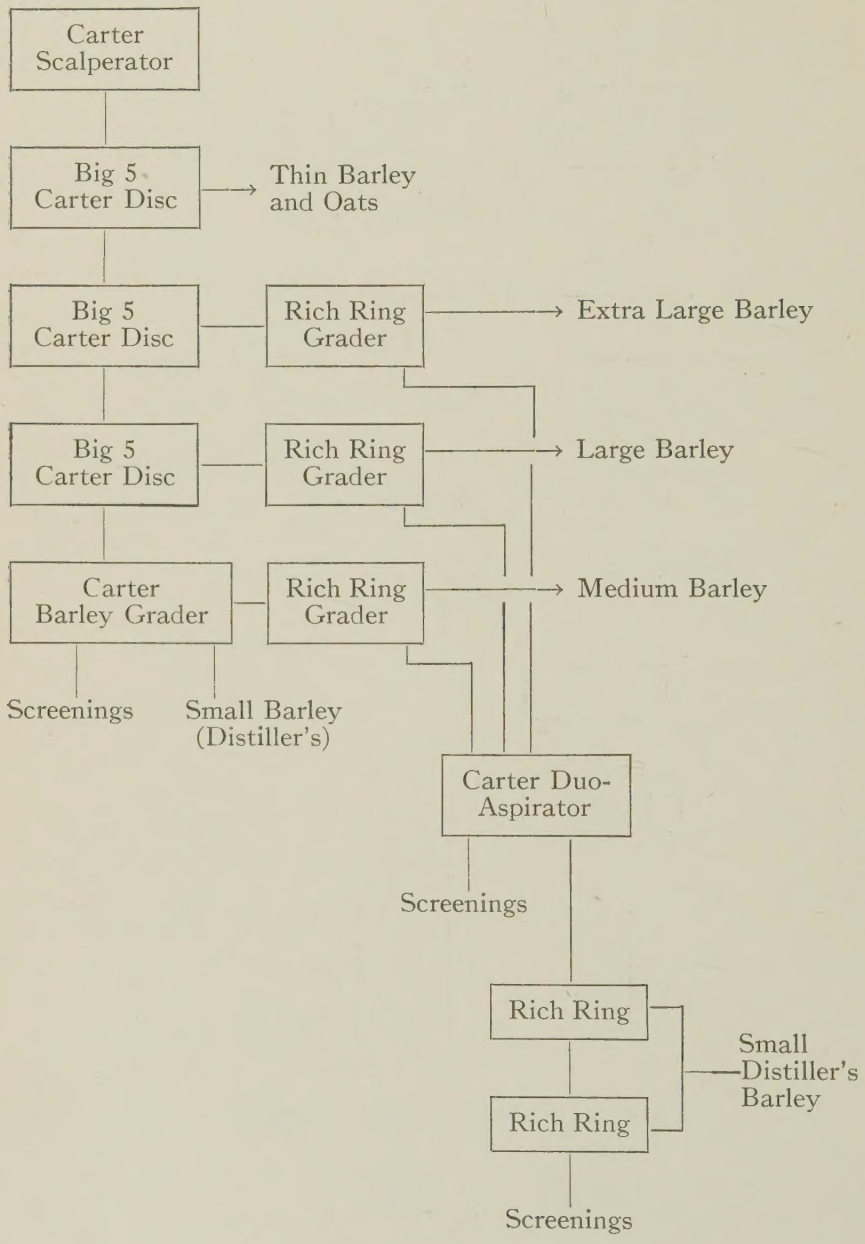

Carter Scalperator
Big 5 Carter Disc
Thin Barley and Oats
Big 5 Carter Disc
Rich Ring Grader
Extra Large Barley
Big 5 Carter Disc
Rich Ring Grader
Large Barley
Carter Barley Grader
Rich Ring Grader
Medium Barley
Screenings
Small Barley (Distiller's)
Carter Duo-Aspirator
Screenings
Rich Ring
Small Distiller's Barley
Rich Ring
Screenings

FIGURE 9

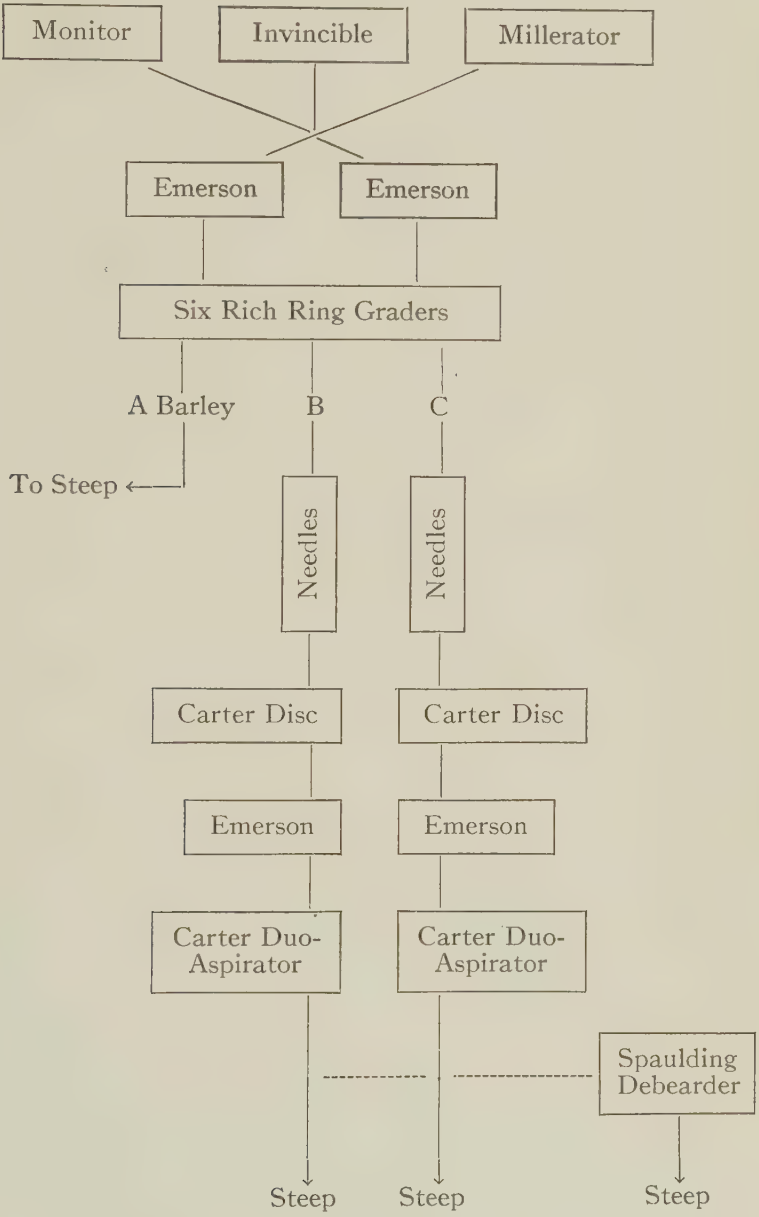

Monitor
Invincible
Millerator
Emerson
Emerson
Six Rich Ring Graders
A Barley
B
C
To Steep
Needles
Needles
Carter Disc
Carter Disc
Emerson
Emerson
Carter Duo-Aspirator
Carter Duo-Aspirator
Spaulding Debearder
Steep
Steep
Steep

FIGURE 10

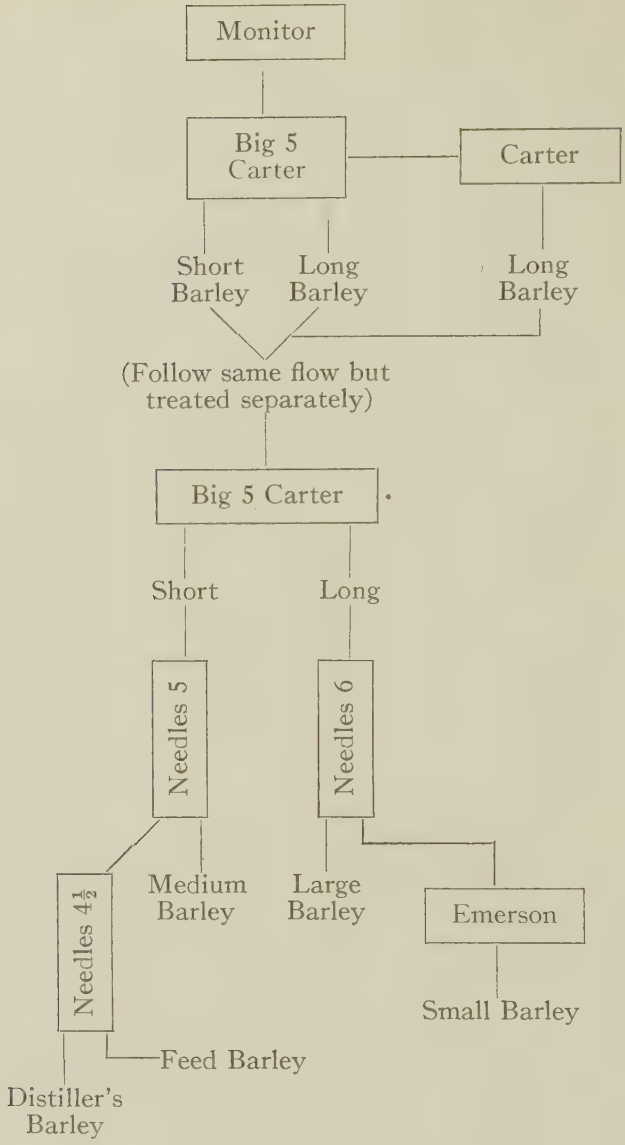



FIGURE 11

elevating. In malt-houses, the general arrangement of the cleaning machinery is vertical. As far as possible the grain moves from machine to machine by gravity and the necessity of elevating is reduced to a minimum.

*English Systems.* The cleaning plants in English maltings are, in general, much simpler than plants on this continent. There are two reasons for this. It is not common practice to divide the barley into two sizes before malting, though, of course, small thin kernels are removed. English maltsters generally have to deal with grain that is practically free

from impurities. It is only necessary to remove a comparatively small amount of foreign material, seeds, and broken kernels. Their plants are not designed to handle grain containing a high percentage of wild oats.

In many cases, the machines are arranged on a single floor. The grain is transferred from one machine to another by small unit elevators. The handling is therefore much less than in terminal elevators having all their cleaning machinery on one floor, where the grain has to be elevated to the top of the house and dropped into the garner over the next machine.

Examples of English cleaning systems are given in Figures 12 to 20.

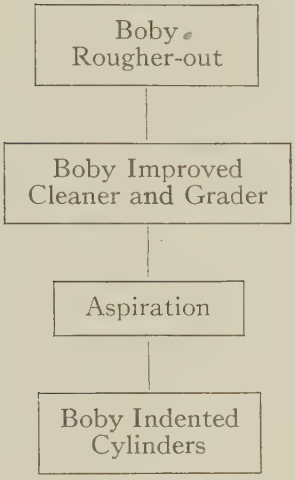



FIGURE 12

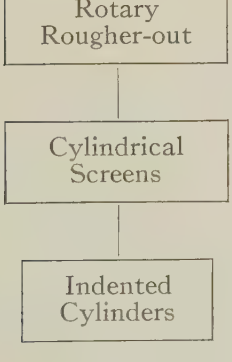



FIGURE 13

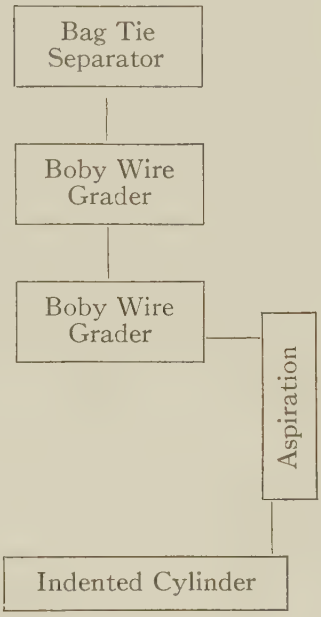



FIGURE 14

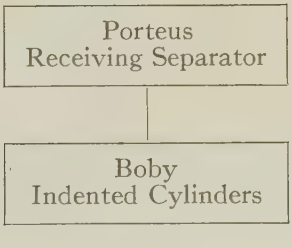



FIGURE 15

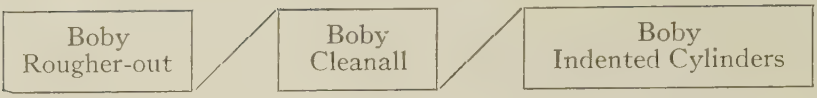



FIGURE 16

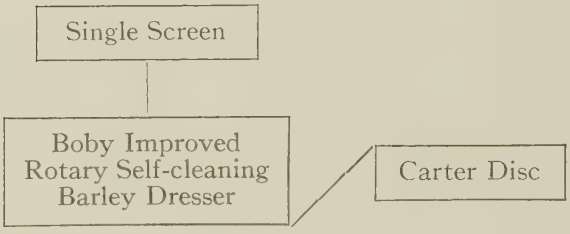
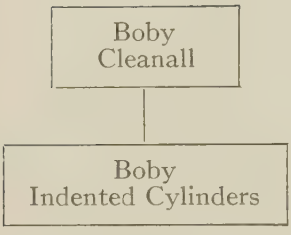



FIGURE 17

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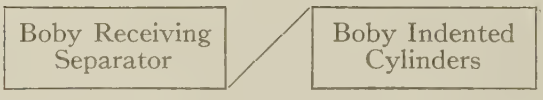


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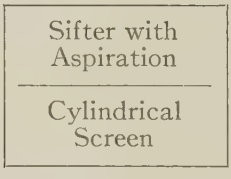


(NOTE.—The two machines are combined in one unit under the name of the Porteus Barley Separator and Dust Extractor)

FIGURE 20

*Continental European Systems.* These, in general, are intermediate between the American and the English systems. Some European maltsters separate the barley into two grades before malting but they are dealing with cleaner barley than is common in this country.

Examples are given in Figures 21 to 26.

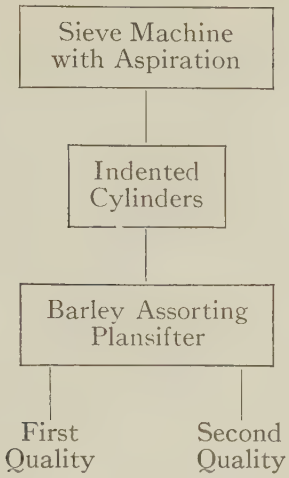


FIGURE 21

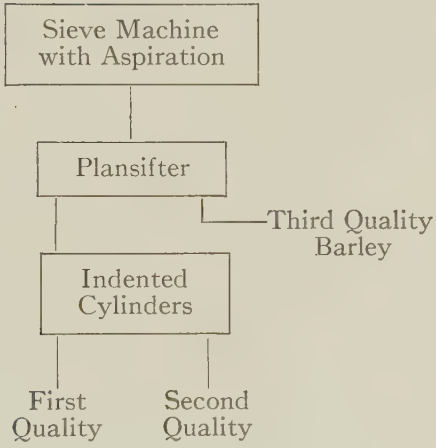


FIGURE 22

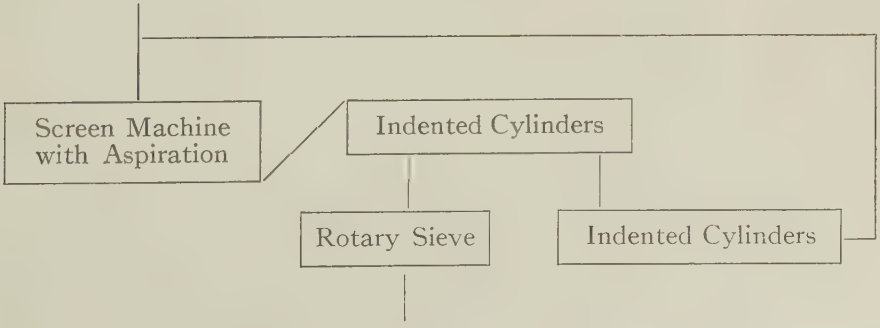


FIGURE 23

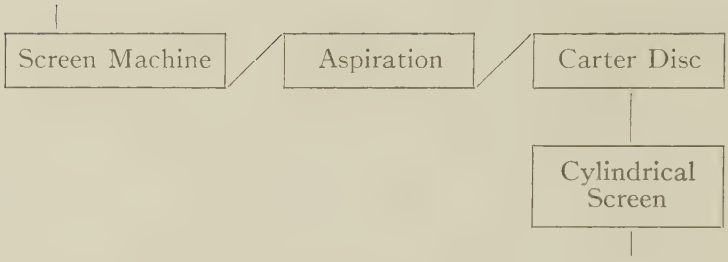


FIGURE 24

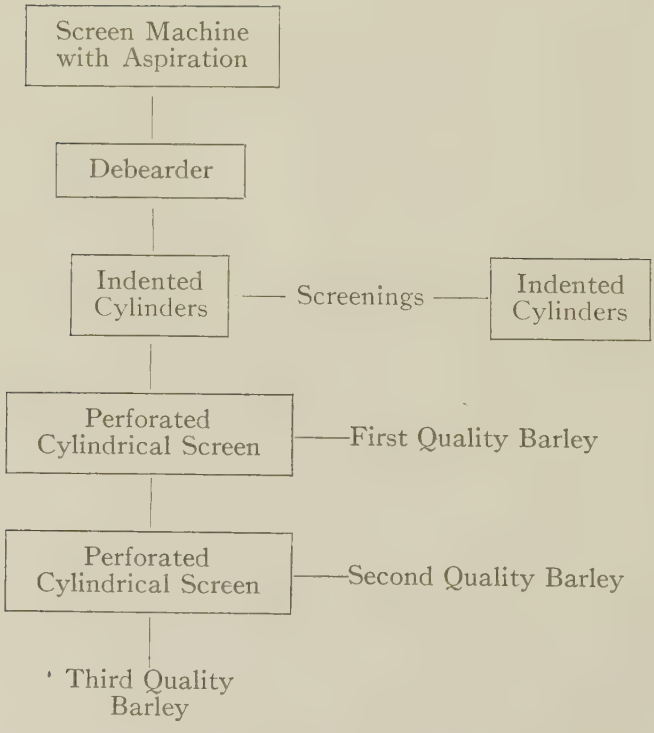


FIGURE 25

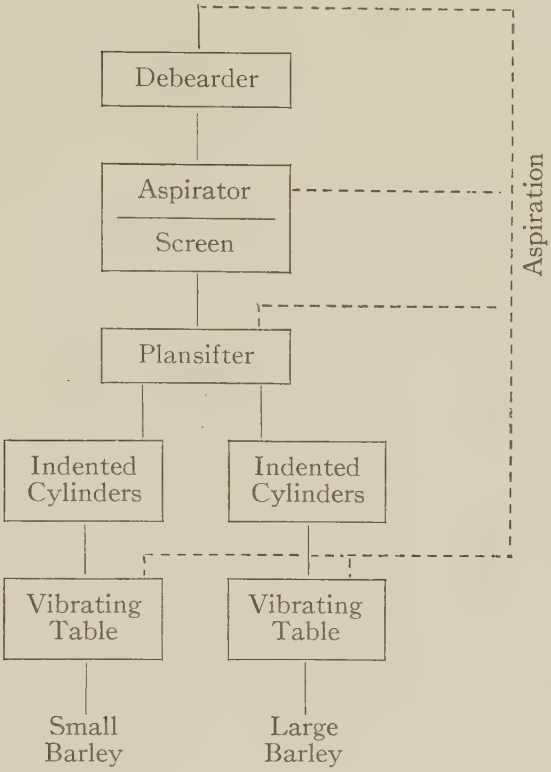


FIGURE 26

## PEELING OR SKINNING

### Objections to Peeled Kernels

Malting barley must be free not only from foreign grains, weed seeds, and dirt, but also from peeled or skinned kernels. The maltsters object to the presence of such damaged grains on several grounds:

1. The germ may be injured or removed, and such kernels are essentially inert matter. Their presence reduces the extract and the diastatic activity of the malt.

2. Even when the germ is not injured, partial peeling may permit the acrospire to push its way through the damaged hull and it is then subject to injury when the grain is stirred, checking development and modification with resultant lowering of the extract and diastase.

3. Under the English system of malting, the presence of damaged kernels favours mould growth. This mould may spread to sound kernels in proximity to the damaged ones, aggravating the primary deleterious effect.

4. Even if germination is not destroyed, the acrospire is not injured, and no mould grows, peeled kernels are objectionable because their presence gives the malt a ragged appearance, thereby reducing its saleability.

5. The hull is valuable as an aid to filtration and any loss of hull, or any hull injury which favours pulverization in the milling of the malt, interferes with proper drainage of the mash and results in lower extract.

The deleterious effect of skinning is well illustrated by figures given by Pritchard (*5*) which are shown in Table 1.

TABLE 1.—EFFECT OF SKINNING ON GERMINATION AND GROWTH

| No. | Sample | Germination, % | Acrospires escaped, % |
|---|---|---|---|
| 1 | Good quality English malting barley | 100 | 1 |
| 2 | Ended or chipped grains from Australian Chevalier Barley | 100 | 20 |
| 3 | Skinned grains with embryo exposed from Australian Chevalier Barley | 76 | 65 |

The figures show that, while minor injuries did not affect germination, they allowed acrospires to escape and reduced the quality of the malt. The severe injury in Sample 3 reduced germination, allowed the acrospires to escape, and, in addition, 70% of the kernels in this sample were affected by mould growth.

## Tolerance for Peeled Kernels

Maltsters want barley which is absolutely free from peeling damage. This, of course, is an ideal, and the percentage of damage which the maltsters will tolerate is governed largely by the percentage of damage which they may expect to find in a reasonably good sample of the barley available. Any general improvement in the barley would likely result in a lowering of the maltster's tolerance.

In Canada, they will tolerate up to about 4% of damaged kernels, although they regard this percentage as evidence of rough handling or poor adherence of the hull, either of which may lead to the loss of 15% of the hulls in malting. Pritchard (*5*) reports that in England the standard required for good English barley is not more than 1.2% of injured grains of all kinds, and that they will allow up to 4% in Australian barley. In South Australia, the average sample contains 1.2% of damaged grains, and maltsters will not accept barley having more than approximately 3%.

## Determination of Damage

In the survey attempts were made to determine the main sources of peeling damage. Where possible, samples were taken before and after the operations under observation. Care was taken to obtain representative samples, but in a few cases this was not feasible because strict sampling technique would have required several samples to be taken simultaneously. In some cases samples previously collected by elevator operators and others had to be used.

The samples, weighing usually from one to three pounds, were taken to the National Research Laboratories for determination of the percentage damage. After the removal of the weed seeds and trash the samples for these determinations were obtained by coning and quartering each sample collected in the field to give a sample containing approximately 1,500 kernels. These in turn were sampled to give three subsamples of

approximately 500 kernels each, on which the counts were made, the three results then being averaged. Kernels from which any of the hull had been removed were classed as "peeled" and are reported as a percentage of the unbroken kernels (*i.e.*, as a percentage of the total number of kernels in the sample after removal of the cracked grain). In order to give an idea of the severity of the damage as distinct from its extent, those kernels which were essentially naked were separated from the peeled kernels. Most of these had some shreds of hull still adhering, but for all practical purposes they could be regarded as completely peeled. Their number is reported as a percentage of the unbroken kernels in the sample under the heading "Severely peeled." It should be noted that the percentage of peeled kernels includes the severely peeled kernels. The cracked kernels are reported separately as a percentage of the unbroken kernels.

A series of 10 determinations (each in triplicate) was made using grain drawn from a single sample, and following the above technique. The standard deviation of a single determination (1,500 kernels) was 0.31% for the "peeled" kernels. The minimum significant difference between single determinations would therefore be approximately 1%. If the error of sampling in the field, which is unknown, were added, the requisite difference would be greater. In most cases, of course, comparisons are not made between single samples but between the averages of series of samples, and the accuracy is increased according to the number of samples in the series.

The standard deviation of a single count of 500 kernels was 0.84. Comparison of the variances shows that the sampling procedure was more effective for obtaining representative samples of 1,500 from the bulk than it was for obtaining representative subsamples of 500 from the samples of 1,500.

It was considered that 1,500 kernels was the smallest number that could be counted to obtain reasonable accuracy. There is no statistical advantage in counting three lots of 500 rather than a single lot of 1,500, but there is the practical advantage that any mistakes can be more readily detected. The procedure outlined above was therefore adopted for the determination of damage in all of the survey samples.

## Sources of Damage

### Damage in Threshing

The survey was started too late in the season for many samples to be obtained directly from threshing machines in operation, but a number of samples were collected as the grain was delivered to the country elevators and these essentially represent the grain as threshed. No samples of frosted grain were included in this collection, as any trace of frost renders the barley unfit for malting. Table 2 shows the results of the counts of damaged kernels in these samples.

Table 2.—Damage caused by threshing (1934)

| Grade | Number of samples | Damage, % | | |
|---|---|---|---|---|
| | | Peeled | Severely peeled | Cracked |
| 3 extra, 6-row | 94 | 3.4 | 0.2 | 1.1 |
| 3 C.W. | 34 | 3.7 | 0.3 | 1.3 |
| All samples | 177 | 3.6 | 0.4 | 1.2 |

11729—2½

It is noteworthy that grade had no marked influence on the percentage of peeling. This, of course, was to be expected since, in a series free from frost damage, cleanliness and not quality is the chief grading factor. The average percentage of damage is perilously close to the limit of tolerance of the Canadian maltsters. There is no leeway for unavoidable damage during subsequent handling.

Only one sample out of the 177 showed no damage, and one contained over 13% of damaged kernels. However, about a quarter of the samples contained less than 2% of peeled kernels so that it is evident that it is possible to thresh barley with less than 2% damage under actual farm conditions. At present 2% of damage in the barley as it leaves the farm might be considered reasonable. To obtain this, it will be necessary for 75% of the barley growers to adopt threshing methods already proved to be practicable by the remaining 25%. At one farm visited while the threshing was in progress, the thresherman was operating his machine with only two rows of teeth in the concaves which were set well down from the cylinder and the barley contained only 1.6% of peeled kernels.

### Damage at Different Stages of Marketing

Table 3 shows the amount of damage found in samples taken at different stages of marketing. The results for threshing damage are taken from Table 2. The figures for the damage in the western malt-house receipts are derived from a series of 20 samples representing maltster's receipts at Winnipeg. The figures for primary inspections and terminal unloads and shipments are based on the monthly average samples of the Inspection Division at the various points. These samples are composites made up of portions of every sample received for grading during the period. The English receipts were studied by means of samples collected from English maltsters using Canadian barley. There were only five samples of 3 extra, and 29 of 3 C.W. It was not possible to follow the same lots of grain throughout and the comparisons are valid only as an indication of the average conditions during the period of study.

Table 3.—Damage at different stages of marketing

| — | Damage, % | | |
|---|---|---|---|
| | Peeled | Severely peeled | Cracked |
| *3 extra 6-row* | | | |
| As threshed | 3.4 | 0.2 | 1.1 |
| Western malt-house receipts | 3.0 | 0.2 | 1.2 |
| Primary inspections and terminal unloads | 4.0 | 1.0 | 1.6 |
| Fort William shipments | 4.4 | 0.8 | 0.9 |
| Montreal shipments | 6.2 | 1.3 | 0.5 |
| English receipts | 8.4 | 1.2 | 1.5 |
| *3 C.W.* | | | |
| As threshed | 3.7 | 0.3 | 1.3 |
| Primary inspections and terminal unloads | 5.5 | 1.5 | 2.2 |
| Fort William shipments | 6.6 | 1.4 | 2.5 |
| Montreal shipments | 7.5 | 1.9 | 4.0 |
| Vancouver shipments | 5.1 | 0.8 | 1.0 |
| English receipts | 9.0 | 1.9 | 2.3 |

In general there is an increase in damage at each stage. It should be pointed out, however, that this does not necessarily indicate rough handling. It is probable that much of the apparent increase can be attributed to selection and diversion of the less damaged lots or to changes in grading by cleaning or mixing. For example, in 3 extra 6-row, the increase in the percentage of damage from 3.4% at threshing to 4.0% at the primary inspection points and terminals cannot be taken as a definite indication of damage in country elevators, since a considerable quantity of barley averaging 3.0% damage was diverted to the malt-houses. At the same stages of marketing there was an increase in damage in 3 C.W. from 3.7% to 5.5%. However, it will be remembered that in the samples collected for the study of threshing damage no frosted barley was included while the inspection averages and terminal unloads contained a normal percentage of frosted grain, which is easily damaged.

The difference between the primary inspections and the Fort William shipments of 3 C.W. is probably due in part to the cleaning of the best of the 3 C.W. to make 3 extra and in part to the lower percentage of damage in the grain moving to Vancouver. The barley graded at Edmonton and Calgary showed slightly less damage than the receipts at Fort William, so that the lower amount of damage in the Vancouver shipments cannot be entirely attributed to the lesser amount of handling which the grain receives on this route, though this was undoubtedly a factor.

There is quite a marked increase in the damage found in the English receipts as compared with our export shipments. While it is probable that the small number of samples (particularly in 3 extra) does not adequately represent the average of the receipts, these results can be taken as an indication that damage to our barley sometimes occurs during unloading on the other side of the Atlantic.

Some English buyers have expressed the opinion that pneumatic unloading machines cause undue peeling damage to barley. While no samples taken before and after unloading with one of these machines have been obtained, a consideration of the principle involved would make it seem that this opinion is correct. There must be severe impact whenever grain travelling at high velocity is forced to change direction in the ducts. There are none of these machines installed in any Canadian elevator. Bucket elevators and marine legs are used exclusively.

One shipment of 3 extra C.W. which was traced from Port Arthur to England showed 7.8% damage as received in the terminal, 6.9% after cleaning, and 7.7% as received in England. While the type of unloading used is not definitely known, the firm importing this shipment insist on the use of bucket elevators where possible.

Whatever the cause may be, there is undoubtedly an increase in the percentage of damaged kernels as the grain moves from the farm to the consumer. The part which the actual mechanical handling plays in this increase can only be determined by observation of the processes concerned, and definite conclusions can only be drawn after several years' observation because of the possible influence of seasonal conditions. This year's results will be discussed further in the succeeding sections. It is evident from the table, however, that, in the past season, the greatest damage at any single stage of handling occurred at threshing. If allowance is made

for the possible effect of selection and mixing, the importance of the damage at threshing becomes more marked.

### Damage in Cleaning

The possibility of damage in cleaning in country and terminal elevators was investigated. Table 4 shows that there was a reduction in the percentage of damage in the cleaned samples which were obtained from 15 machines. In spite of this result, there is, of course, a possibility that damage was occurring and that these kernels were being removed along with a certain percentage of those previously damaged. If such were the the case, the amount of damage must have been slight. This point will be further investigated next year.

Only one cleaner examined was definitely damaging the barley. This cleaner was an old model, fitted with screw conveyers which ran with very little clearance. This defect has been remedied in later models of this make.

Another instance of damage in connection with cleaning, but not in the cleaner itself, was observed. A screw conveyer about 12 feet long was used to remove the grain from the machine and, in passage through it, the percentage of damaged kernels rose from 3.9 to 5.9. That screw conveyers are not inherently destructive is proved by the fact that in others observed no damage was occurring. However, care must be taken that the clearance is sufficient, that the screw is not bent, and that it is in proper alignment.

The smaller percentage of peeled kernels in the cleaned samples is attributable to the reduction in size incident to peeling. Peeled kernels are smaller than normal kernels and thus they are more nearly similar in size to wheat and tend to be removed with it. A similar separation of peeled kernels with the smaller grains is illustrated in the second part of Table 4. These samples were taken from cleaners which deliver two sizes of cleaned grain. It will be noted that there is an appreciably higher percentage of damaged kernels in the small barley.

Table 4.—Effect of cleaning on damage (1934)

| — | Damage, % | | |
|---|---|---|---|
| | Peeled | Severely peeled | Cracked |
| Country elevators, before cleaning | 5.6 | 1.0 | 1.5 |
| after cleaning | 4.6 | 1.1 | 1.5 |
| Terminal elevators, before cleaning | 4.4 | 0.5 | 1.2 |
| after cleaning | 3.7 | 0.3 | 0.9 |
| Sized samples, before cleaning | 4.4 | 0.5 | 1.5 |
| after cleaning, large barley | 2.8 | 0.2 | 0.2 |
| after cleaning, small barley | 5.2 | 0.6 | 2.1 |

### Damage in Handling

The samples which were collected in the country elevators showed only a fractional increase in damage after being elevated and dropped into a bin or car. In country elevators, the rate of movement of the grain is

slow compared to that in the terminals, and unless the adherence of the hull were poor, excessive damage is not to be expected in normal operation. The possibility of damage in screw conveyers was mentioned in the previous section, but these are rarely used except in connection with cleaning machinery.

TABLE 5.—DAMAGE IN TERMINAL ELEVATOR OPERATION

| Operation | Damage before operation, % | | | Damage after operation, % | | |
|---|---|---|---|---|---|---|
| | Peeled | Severely peeled | Cracked | Peeled | Severely peeled | Cracked |
| Elevation | 3.4 | 0.5 | 1.8 | 3.4 | 0.4 | 1.2 |
| Elevation | 4.8 | 0.6 | 0.8 | 4.7 | 0.7 | 1.6 |
| Elevation | 4.8 | 0.1 | 1.8 | 4.3 | 0.1 | 1.6 |
| Elevation | 5.2 | 0.7 | 1.3 | 4.5 | 0.1 | 1.4 |
| Elevation and drop to boat | 3.2 | 0.3 | 1.8 | 2.8 | 0.5 | 1.9 |
| Elevation and drop to boat | 6.1 | 0.3 | 1.7 | 5.6 | 0.4 | 1.5 |
| Elevation and drop to boat | 5.8 | 0.6 | 1.3 | 5.1 | 0.5 | 1.2 |
| Drop from belt to bin or scale | 3.4 | 0.4 | 1.2 | 3.5 | 0.4 | 1.6 |
| Drop from belt to bin or scale | 4.7 | 0.7 | 1.6 | 4.6 | 0.2 | 1.0 |
| Drop from belt to bin or scale | 4.3 | 0.1 | 1.6 | 4.5 | 0.5 | 1.0 |
| Drop from belt to bin or scale | 4.5 | 0.1 | 1.4 | 4.4 | 1.0 | 1.0 |
| Drop from scale to boat | 4.5 | 0.5 | 1.0 | 4.5 | 0.3 | 1.6 |
| Drop from scale to boat | 4.4 | 1.0 | 1.0 | 4.9 | 0.3 | 1.6 |
| Cleaned, elevated, and dropped to bin | 4.1 | 0.3 | 0.9 | 4.5 | 0.2 | 1.0 |

The results from a series of samples drawn during normal operation of terminal elevators at the Head of the Lakes are given in Table 5. In interpreting this table, it must be remembered that the data given are for single samples and that the error of the subsampling alone makes differences of less than 1% statistically insignificant. It is apparent, therefore, that these results give no evidence of damage to barley during handling in terminal elevators.

On the average, these figures agree very well with those given in Table 3 for the damage in Fort William shipments of 3 extra. Since the figures in Table 3 are based on collections over several weeks, we can assume that the damage in handling in the terminals during the present season was comparatively unimportant.

This conclusion should not be taken as meaning that damage never occurs in the terminals. An experiment in which the barley was specially handled in a manner that might be expected to produce damage was conducted in the Government Elevator at Edmonton. A parcel of 3 C.W. was dropped from a workhouse bin on to a grate and elevated back to the bin, this process being carried out three times, samples being taken in duplicate as the grain dropped. The results are given in Table 6.

TABLE 6.—DAMAGE IN EXPERIMENTAL HANDLING IN A TERMINAL

| Sample | Damage, % | | |
|---|---|---|---|
| | Peeled | Severely peeled | Cracked |
| First Drop | 10.4 | 4.9 | 2.4 |
| Second Drop | 10.5 | 4.3 | 2.1 |
| Third Drop | 11.5 | 6.3 | 2.9 |

The first handling did not give rise to any pronounced increase in the amount of damage, which was already quite high. However, the attachment of the hull must have been affected, as an appreciable difference is shown between the second and third sampling. The increase in the percentage of severely peeled kernels is particularly noteworthy, as such kernels are absolutely useless to the maltster.

Whenever barley is handled in an elevator, the air is full of dust and fine pieces of hull. In normal operation, this season, these pieces of hull must have come principally from kernels already showing slight damage. In the Edmonton experiment, this type of damage was sufficiently extensive to be reflected in the counts. It is the common observation of elevator operators that in some years quite extensive damage has occurred. It must be assumed, therefore, that there are seasonal influences which affect the susceptibility to peeling and that, in some years, damage may result from handling in the terminals. During the periods of heavy grain movement, a car of barley may be unloaded and stored in the annex until it is convenient to clean it. It is then moved to the cleaner bins in the workhouse and may be returned to the large bins for further storage before being shipped. Occasionally it may be necessary to weigh a certain grade in order to check the stocks and this involves further handling. It is quite possible for barley to be elevated five or six times in all before shipping. If in any year the climatic conditions favour loose attachment of the hull, there would be danger of damage from this repeated handling.

Unfortunately it has not been possible to determine definitely from this year's results the operations which are responsible for the damage when it does occur. We have some indication from the Edmonton experiment that dropping into the bins may be important. It is reasonable to expect that, if the barley is at all susceptible, striking the concrete wall of a bin at high velocity will cause damage. Other possible sources of damage that have been suggested are the churning of the grain in elevator boots, improperly constructed screw conveyers, and cleaning machinery. It is doubtful if the first and last of these ever cause serious damage, and, while bad screw conveyers would cause damage, their use in terminals is rare.

## Laboratory Experiments

### Experimental Damaging Machine

In order to study the factors which influence the susceptibility of barley to mechanical damage, it was necessary to find some way of subjecting the grain to uniformly harsh treatment. The machine which was devised is shown in Figure 27. The grain is fed through a hopper and tube to the periphery of the blades of a 1,750 r.p.m. blower-type fan. It is struck by the blades and thrown forcibly against a heavy wire mesh at the end of a cylindrical chamber. This chamber, which was made from a 5-lb. baking-powder can, is sufficiently long so that the kernels do not bounce back into the fan, and it can be lifted off to permit removal of the sample. In order to ensure uniform treatment, it is necessary to feed the kernels singly. This is done by placing them, about 100 at a time, in a V-shaped tin slide about 14 inches long and tapping the end.

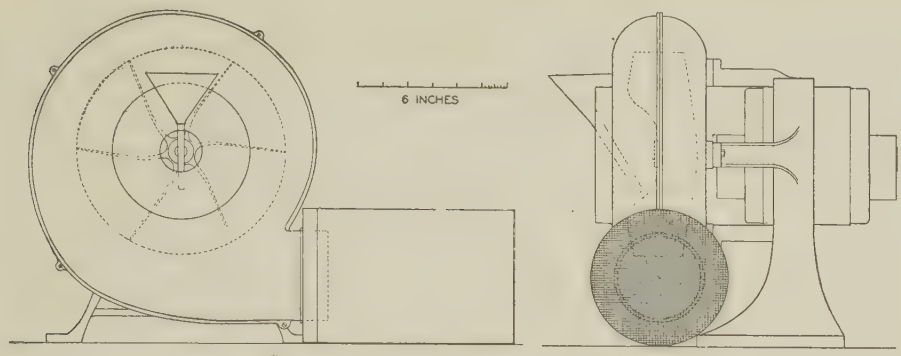


FIGURE 27. Barley damaging machine.

Table 7 shows the agreement obtained in four trials at different damage levels between three replicates of 1,000 sound kernels drawn from the same sample of grain.

In making the tests, three lots of 1,000 undamaged kernels were used and, except in the experiment on progressive damage, the samples were put through the machine three times before the counts were made. The results reported are averages of the damage in the triplicate samples.

TABLE 7.—AGREEMENT OF TRIPLICATE DAMAGE TESTS

| Sample | Damage, % | | |
|---|---|---|---|
| | Peeled | Severely peeled | Cracked |
| 1 A | 10.4 | 0.3 | 0.7 |
| B | 9.3 | 0.4 | 0.7 |
| C | 9.3 | 0.4 | 0.6 |
| 2 A | 21.2 | 2.5 | 2.1 |
| B | 19.2 | 1.4 | 2.0 |
| C | 20.5 | 1.4 | 3.3 |
| 3 A | 30.5 | 2.3 | 2.3 |
| B | 32.9 | 1.8 | 2.9 |
| C | 30.2 | 2.7 | 2.8 |
| 4 A | 50.6 | 9.1 | 3.9 |
| B | 50.0 | 9.9 | 2.3 |
| C | 47.2 | 9.2 | 2.3 |

## EFFECT OF REPEATED ROUGH HANDLING

The first experiment in which the damaging machine was used was designed to test the effect of rough handling on the peeling resulting from subsequent handling. It seemed likely that rough handling at any stage might not only remove the loosely attached hulls but also partially loosen some of the remaining ones, thus increasing the proportion lost in later handlings. To determine whether there was a cumulative effect of this sort on apparent susceptibility to damage in handling, three lots of 1,000 undamaged kernels were each put through the machine three times and the damage counted after each treatment. The average results for each of these counts is reported in Table 8.

The results show that the damage caused by a single rough handling increases each time the grain is so handled. The kernels peeled in a single treatment increased from 7.4% the first time the grain was put through the machine to 19.5% the third time it was put through. The increase in the percentage of severely peeled kernels is equally striking.

TABLE 8.—EFFECT OF REPEATED ROUGH HANDLING ON DAMAGE IN BARLEY

| Number of treatments | Damage, % | | |
|---|---|---|---|
| | Peeled | Severely peeled | Cracked |
| *Cumulative damage* | | | |
| 1 | 7.4 | 0.5 | 0.1 |
| 2 | 21.8 | 1.2 | 0.6 |
| 3 | 41.3 | 3.6 | 1.0 |
| *Progressive damage* | | | |
| 1 | 7.4 | 0.5 | 0.1 |
| 2 | 14.4 | 0.7 | 0.5 |
| 3 | 19.5 | 2.4 | 0.3 |

These results have an important bearing on the significance of the threshing damage found in the survey. They indicate that damage in threshing will increase the susceptibility of the grain to damage at the later stages of marketing. Any improvement in threshing should, therefore, tend to reduce the damage in the grain as it is delivered to the maltster.

It does not follow, of course, that because the susceptibility to damage is increased actual damage will result. Other factors may supervene. In the present season the threshing damage was relatively high and yet there was little damage in the terminal elevators. The rôle of the high moisture content of the grain in minimizing the damage in the terminals will be discussed in the next section.

### EFFECT OF MOISTURE CONTENT OF THE GRAIN

In order to study this, it was necessary to have some means of adjusting different samples of the same lot of grain to different moisture contents. Since no naturally tough grain was available, high moisture samples were provided by tempering, that is, by adding water to the grain and allowing it to stand in a closed container to attain equilibrium. There was some doubt about the effect of the wetting on the attachment of the hull and accordingly some experiments were run to determine this.

In a preliminary experiment, a sample of registered O.A.C. 21 (moisture content 8.6%) was split into two portions. One of these was tempered to 16.2% and allowed to dry again to 8.6%; the other was untreated. The tempered sample showed 61.5% peeled kernels in the damage test and the untempered sample 51.8%. In a second experiment, a sample of Peatland and a sample of commercial O.A.C. 21 were used. The procedure was the same as in the first experiment, except that both the tempered and untempered samples were allowed to dry down from the original moisture content and damage tests were made on subsamples drawn at different moisture levels. The results are shown in Figures 28 and 29. It will be seen that the untempered sample showed less damage in each case, the difference in the Peatland being about 5% and in O.A.C. 21, about 10%.

In a third experiment, another sample of commercial O.A.C. 21 was divided into portions which were tempered to 15%, 17%, and 19% respectively, with one portion left untempered as a check. The tempered samples were allowed to dry to the original moisture content and damage tests were run on all the samples. The results are given in Table 9. It will be seen that the difference between the tempered sample and the check increased with the amount of water added.

These results have a practical significance apart from their relation to our laboratory technique. They show that susceptibility to damage may be increased if grain is subjected to wetting and drying in the stook. The practice of capping barley stooks and discarding the cap stook if the grain has stood out in rainy weather would probably reduce the threshing damage as well as improving the colour of the grain.

TABLE 9.—EFFECT OF WETTING AND DRYING ON DAMAGE

| Tempered to, % moisture | Damage, % | | |
|---|---|---|---|
| | Peeled | Severely peeled | Cracked |
| Check | 36.9 | 3.4 | 1.7 |
| 15 | 42.2 | 6.6 | 1.2 |
| 17 | 44.0 | 8.7 | 2.3 |
| 19 | 49.3 | 9.4 | 2.8 |

It is clear from Figures 28 and 29 that damage decreases as moisture content increases, but Table 9 indicates that this reduction will not be as great with artificially moistened grain. In a further experiment, a sample of registered O.A.C. 21 (original moisture 9.4%) and a sample of Peatland (original moisture 12.3%) were used. To obtain samples above the original moisture (indicated by a cross line on the curves) the samples were tempered to approximately 17% and allowed to dry down. Samples below the original moisture were obtained by air drying. The solid lines in Figure 30 show the actual experimental results. On the basis of the earlier results (Figures 28 and 29), a hypothetical approximation to the curves which might have been obtained with untempered samples is indicated by broken lines.

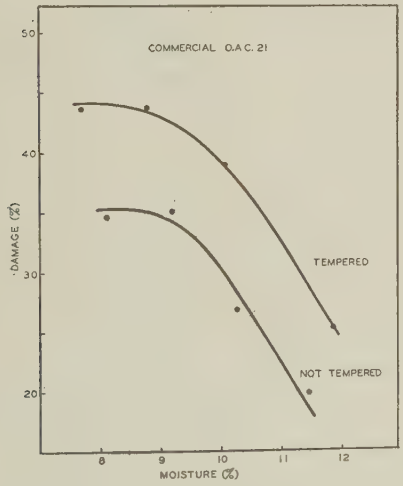


FIGURE 28. Effect of moisture content on peeling in tempered and untempered samples (O.A.C. 21).

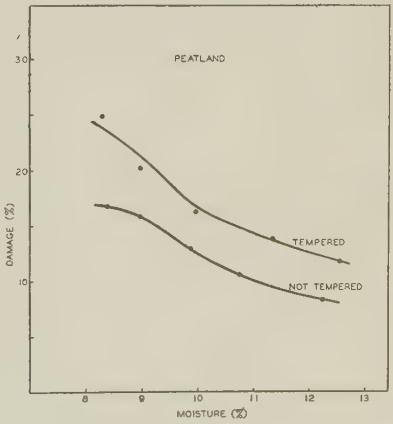


FIGURE 29. Effect of moisture content on peeling in tempered and untempered samples (Peatland).

Here again the damage decreases with increase in the moisture content of the grain. In the case of samples which are very susceptible when dry, the decrease is very marked. This effect of moisture content is sufficient to explain the small injury to barley in the terminals this year.

All the samples collected contained over 14% moisture and consequently were not nearly so susceptible to damage as they would have been had they contained only 12% moisture. The relation between moisture and damage is important to the farmer, since it shows that barley should be threshed at as high a moisture content as possible. It should not be allowed to dry in the stook very much below the point at which it would be graded tough (14.8%).

### Effect of Humidity and Temperature

The effect of humidity on damage was studied with two series of samples. A single lot of grain with a moisture content of 10.9% was divided into two portions, one of which was allowed to dry down to 8.5%. A sufficient number of subsamples of 1000 undamaged kernels each were counted out. During this counting the moisture content of the higher portion dropped to 10.4%. The damaging machine was set up in an air-conditioned room held at the humidities and temperatures shown in the table. When the determinations were made, the samples, in triplicate, were taken into the room and one set was put through the machine immediately; the other two were exposed in shallow layers for one-half and two hours respectively before treatment. Special samples for the moisture determinations were similarly treated.

As a matter of interest, a short series was run at a higher temperature.

The results are given in Table 10.

Table 10.—Effect of humidity and temperature on damage to barley

| Treatment | | | Moisture after treating, % | Damage, % | | |
|---|---|---|---|---|---|---|
| Humidity, % | Temp., ° F. | Exposure, hr. | | Peeled | Severely peeled | Cracked |
| Series I | | | | | | |
| 40 | 70 | 0 | 10.4 | 22.9 | 1.0 | 1.3 |
| | | ½ | 10.5 | 22.3 | 1.0 | 1.2 |
| | | 2 | 10.6 | 24.1 | 1.3 | 1.1 |
| 60 | 70 | 0 | 10.4 | 20.6 | 1.4 | 1.4 |
| | | ½ | 10.7 | 17.8 | 1.1 | 1.9 |
| | | 2 | 11.1 | 15.7 | 1.3 | 1.3 |
| 80 | 70 | 0 | 10.4 | 19.0 | 1.3 | 1.0 |
| | | ½ | 10.9 | 9.2 | 0.6 | 1.7 |
| | | 2 | 11.1 | 5.9 | 0.6 | 1.5 |
| Series X | | | | | | |
| 80 | 84 | ½ | 10.9 | 4.6 | 0.3 | 0.9 |
| | | 2 | 11.4 | 3.1 | 0.2 | 0.4 |
| Series II | | | | | | |
| 40 | 70 | 0 | 8.5 | 35.7 | 2.6 | 2.9 |
| | | ½ | 8.6 | 32.3 | 2.1 | 2.4 |
| | | 2 | 8.7 | 33.2 | 2.4 | 2.1 |
| 60 | 70 | 0 | 8.5 | 33.8 | 2.4 | 3.1 |
| | | ½ | 8.8 | 26.3 | 1.8 | 2.7 |
| | | 2 | 8.8 | 17.3 | 1.8 | 2.7 |
| 80 | 70 | 0 | 8.5 | 31.2 | 2.3 | 2.7 |
| | | ½ | 8.9 | 15.6 | 0.8 | 2.7 |
| | | 2 | 9.2 | 7.0 | 0.6 | 2.3 |

In Series I, the higher moisture series, there was no appreciable change in the damage at 40% humidity even after two hours' exposure, and in Series II at the same humidity, the decrease was slight. At the higher humidities, both series showed decreases, more marked, of course, in the low-moisture series. The damage decreased, even in those samples which were treated immediately, as the humidity increased.

There was an increase in the moisture content of the kernels with exposure, more marked at the higher humidities. Reference to Figure 30 will show that this increase would not explain the large decreases in damage, if the moisture were uniformly distributed throughout the kernel. Under the conditions of the experiment, the moisture would be absorbed almost wholly by the hull which would accordingly have a much higher water content than that indicated for the whole kernels.

The great effect of high atmospheric humidity in reducing damage is the basis of the common recommendation that threshing of malting barley should be done in the mornings or on cloudy days when the humidity is likely to be high. This, of course, will not apply to the same extent when threshing is done from a stack, as then moisture conditions in the stack would be the predominating influence.

The short temperature series (Series X) shows that high temperatures, of themselves, are not necessarily detrimental. Under field conditions in western Canada, however, high temperatures are generally associated with low relative humidities and usually increased damage will result from threshing on hot days.

### Varietal and Environmental Differences

A few comparisons of the susceptibility of different varieties of barley to mechanical damage were made, in order to demonstrate whether or not varietal differences exist. A series of varieties grown at three different stations was tested. The samples contained $9.0 \pm 0.3\%$ moisture. The results in Table 11 show that varietal differences do exist between the

Table 11.—Differences between varieties

| Station | Variety | Threshing damage, % | | | Test damage, % | | |
|---|---|---|---|---|---|---|---|
| | | Peeled | Severely peeled | Cracked | Peeled | Severely peeled | Cracked |
| 1 | O.A.C. 21 | 9.2 | 0.5 | 0.5 | 39.7 | 3.6 | 0.3 |
| | Wisc. 38 | 8.2 | 0.4 | 0.3 | 29.3 | 4.7 | 0.1 |
| | Regal | 12.3 | 1.0 | 0.5 | 51.7 | 13.7 | 0.4 |
| | Velvet | 9.5 | 0.8 | 0.4 | 42.9 | 17.1 | 0.7 |
| 2 | O.A.C. 21 | 7.0 | 0.5 | 0.3 | 47.5 | 4.3 | 0.4 |
| | Wisc. 38 | 15.6 | 2.1 | 0.7 | 85.3 | 16.5 | 1.7 |
| | Regal | 11.2 | 1.7 | 0.4 | 72.0 | 13.5 | 0.3 |
| | Velvet | 10.7 | 1.2 | 0.5 | 60.6 | 13.5 | 4.4 |
| 3 | O.A.C. 21 | 24.6 | 2.0 | 5.6 | 72.3 | 5.0 | 1.7 |
| | Wisc. 38 | 22.2 | 3.1 | 2.5 | 74.7 | 17.2 | 2.2 |
| | Regal | 35.8 | 6.5 | 2.5 | 91.2 | 18.3 | 0.7 |
| | Velvet | 25.7 | 2.7 | 1.4 | 66.7 | 16.6 | 3.2 |
| Average | O.A.C. 21 | 13.6 | 1.0 | 2.1 | 53.2 | 4.1 | 0.8 |
| | Wisc. 38 | 15.3 | 1.9 | 1.2 | 63.1 | 12.8 | 1.3 |
| | Regal | 19.8 | 3.1 | 1.1 | 71.6 | 15.2 | 0.5 |
| | Velvet | 15.3 | 1.6 | 0.8 | 56.7 | 15.7 | 2.8 |

smooth-awn varieties and between these varieties and O.A.C. 21. In interpreting the table, particular attention should be paid to the percentage of severely peeled kernels. For example, the difference between the average percentages of peeled kernels for Velvet and O.A.C. 21 is not great, but Velvet gave nearly four times the percentage of severely peeled kernels and must therefore be regarded as being much more heavily damaged than O.A.C. 21.

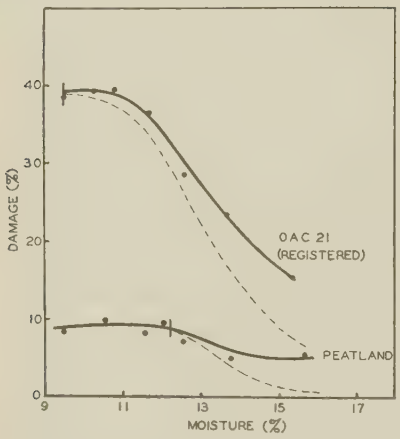


FIGURE 30. Effect of moisture content on peeling.

The data in Figure 30 show that Peatland is less susceptible than O.A.C. 21.

Owing to the fact that the samples were threshed at the station of origin and that the treatment in that operation was not uniform, it is not possible to make direct comparisons of the effect of the environment under which the samples were grown. However, it will be noted that the varieties do not stand in the same relation to one another at the different stations, and this lends support to the view that environmental differences do exist.

## DISCUSSION

The problem of cleaning barley is a comparatively simple one from the mechanical standpoint. The machines now available have a reasonably high degree of efficiency, and at least some of the manufacturers are in a position to design machines to meet special needs. The commercial problem of whether the grain should be cleaned or not is complex. The requirements of the different markets, the price of screenings, the disposal of screenings, the relative saleability of clean and dirty grain, the competition between recleaned screenings and feed grain, and other factors must be taken into account. It is a problem which should receive immediate and intensive study. The recent installation of a large number of cleaners in country elevators will doubtless have an effect on the purity of the grain delivered at the terminals, but it should be pointed out that it is a physical impossibility to clean all the grain moving through the country elevators during the rush season. The development and use of satisfactory cleaners in conjunction with threshing machines would encourage farmers to feed the screenings on the farm and would obviate the inconvenience involved in special farm cleaning or in hauling screenings back to the farm from the local elevator.

The peeling or skinning of malting barley is a very serious problem because it affects the quality of that portion of the barley crop which brings the best price, and for which there is a steady, though not unlimited, market. In order to expand or even to hold our present market for malting barley, it is essential that the quality should be improved and the reduction of the present high percentage of damaged grains would be one step in this direction.

The results of this study show that during the past season a large proportion of the damage is attributable either directly or indirectly to bad threshing. Under different seasonal conditions (*e.g.*, when the average moisture content is low) it is possible that handling in the terminal elevators might contribute substantially to the damage. Even under such conditions, however, it has been shown by experiment that the damage would be minimized by proper threshing.

While there is still need for investigation of methods and equipment for threshing barley, we already know that the damage can be reduced by observing certain simple precautions. Elders and Shanks (*3*) at the Manitoba Agricultural College studied threshing technique, and they recommend: (1) the use of a minimum number of concave teeth, (2) adjusting the chaffer and sieves so as to produce a minimum of grain for re-threshing, (3) keeping the cylinder speed as low as possible, (4) prevention of end play in the cylinder, (5) threshing on cool and cloudy days. Elders continued these studies at the Dominion Experimental Farm, Brandon, and he found that the damage was considerably reduced by threshing during periods of high humidity.[3]

A committee appointed by the Minister of Agriculture of South Australia studied harvest damage to barley. In their report (*9*) they emphasized the necessity of educating the farmer to recognize this type of damage. It takes a trained eye to discover by casual examination the difference between a badly damaged sample containing, say, 15% of skinned kernels and one which contains under 2%. They point out further that the length of time necessary to make adjustments in a threshing machine is a serious deterrent to such adjustments being made. The need for proper adjustment of drum speed, and setting and number of teeth in the concaves, is emphasized in this report and by other Australian investigators (*5*, *6*). They also confirm the importance of weather conditions.

Sim (*7*, *8*), working in South Africa, in addition to covering some of the points already mentioned, advocates uniform heavy feeding of the machine. This, as well as such practices as feeding the sheaves butt first, would tend to reduce the cylinder speed. Sim points out particularly that the cylinder should never be allowed to race and that the engine should be equipped with an efficient governor.

The importance of proper setting and mechanical condition of the threshing machine was pointed out as long ago as 1902 by Baird (*1*).

It is evident from this brief review that immediate steps should be taken to improve the means of making adjustments in threshing machines, particularly in regard to cylinder speed, number of teeth in the concaves and setting of the concaves. However, even with the machines in their present form, it should be possible to reduce the average percentage damage. It was pointed out previously that 25% of the barley growers now thresh barley with less than 2% of damaged kernels, and that therefore proper threshing is by no means impossible with the present equipment under actual farm conditions.

The Sub-Committee on Production and Breeding of the National Barley Committee has prepared educational material to acquaint farmers

[3] Private communication.

with the harmful effects of skinned kernels, and means of avoiding such damage.

After these are well known, stricter grading of malting barley would have a beneficial effect. At present the regulations define the term "sound," as used in malting grade specifications, as meaning, among other things, "practically free from broken, skinned or otherwise damaged grain." Enforcement of this provision would undoubtedly encourage more careful threshing. It should be pointed out, however, that, since the percentage of damaged kernels is liable to increase with repeated handling, careful consideration would have to be given to the allowable limits at different stages of marketing.

It is essential that farmers who thresh their barley well should not be penalized by losing a grade through faulty determination of the weight per measured bushel. Well-threshed barley with short pieces of awn still attached to the kernels has a lower test weight than similar grain with the awns removed. The Government Inspectors rub off the awns before taking the weight per measured bushel and this practice should be followed in every country elevator.

The fact that varieties differ in their susceptibility to damage makes possible the permanent solution of the problem by the breeding of varieties that are resistant to damage. This character should be used as one of the bases of selection by every plant-breeder working with malting barley. The damaging machine used in this study may be of some use in this connection, although rigid tests with it are somewhat laborious. It might be used, however, in the selection of kernels which are resistant to damage and for testing varieties in the later stages of breeding, while a less time-consuming method could be used for routine tests in the earlier generations. It is possible that, if these were threshed uniformly under reasonably constant conditions of grain moisture and atmospheric humidity, simple examination of the threshed grain might give useful, though not rigid, information.

## SUMMARY

1. The barley cleaning and handling practices in Canada were investigated by a survey supplemented by laboratory experiments and information from importing and competing countries.

2. The different types of cleaning devices are discussed.

3. Barley can be cleaned to any desired degree of purity with the machinery now available.

4. Malt-house cleaning systems are most complex and efficient in America, simplest in England, and intermediate in continental Europe. Examples are given.

5. Peeling or skinning decreases the malting value of barley.

6. In 1934, peeling damage was greater at threshing than any other stage of marketing. No damage could be attributed to cleaning or handling in country or terminal elevators, though it was shown that damage may occur in the latter.

7. Using apparatus for damaging barley experimentally, which is described, it was shown that rough handling increases the susceptibility

to subsequent damage and that the susceptibility is also increased by low moisture content of the grain or low atmospheric humidity. Varieties differ in their susceptibility.

8. Methods of reducing the present high level of damage are discussed.

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## Résumé

**L'orge, criblage et utilisation. J. G. Malloch, Laboratoires nationaux de recherches, Ottawa.**

L'enquête en question portait sur les pratiques de criblage et de préparation de l'orge au Canada; elle s'appuyait sur des expériences de laboratoire et des renseignements fournis par les pays importateurs et concurrents. Les différents types d'appareils cribleurs sont passés en revue. Les machines actuellement en usage permettent de nettoyer l'orge à tout degré désiré de pureté. Les systèmes de criblage employés dans les malteries sont plus compliqués et plus efficaces en Amérique que partout ailleurs; plus simples en Angleterre, et intermédiaires dans l'Europe continentale. Des exemples sont donnés. Le décortiquage diminue la valeur de l'orge pour le maltage. En 1934 il y a eu plus de décortiquage au battage que dans toute autre phase de la préparation. Aucune avarie ne peut être attribuée au criblage ou aux manutentions dans les élévateurs de campagne ou terminus, mais il a été démontré cependant que ces derniers peuvent causer des dommages. Une machine spéciale, dont la description est donnée, a été employée pour endommager l'orge expérimentalement et on a constaté que les manutentions brutales augmentent la sensibilité aux avaries, et que cette sensibilité est encore accrue par la faible proportion d'humidité que renferme le grain ou l'atmosphère. Les variétés diffèrent dans leur sensibilité. Les moyens de détruire le taux élevé actuel des avaries sont discutés.

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# A STUDY OF CERTAIN BREEDING PRACTICES IN PIG PRODUCTION

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## INTRODUCTION

In a survey of livestock breeding methods, one cannot but be impressed by the success which has crowned the efforts of livestock producers in certain countries. The stock man visiting the Smithfield Market, the most discriminating meat market in the world, invariably feels a desire to investigate the breeding methods which have been followed in the production of the products there on display. He finds that Danish bacon, Canterbury lamb from New Zealand, and the choicest beef from England and Scotland are to a significant degree the products of crossbreeding. This would seem to indicate that similar breeding methods might be used to advantage in Canada.

The practice of crossbreeding domestic animals is not new. The theory that crossbreeding is accompanied by increased vigor and improved feeding qualities has long been held by breeders. Much of the experimental evidence, however, is contradictory, and there is obvious need for well organized experiments which would systematically put the practice to the test and demonstrate its advantages and disadvantages as far as breeding ability, type, feeding qualities, and general suitability for market are concerned.

Technically, crossbreeding refers to the mating of purebred animals of distinctly different breeds. We may, however, conceive of degrees of crossbreeding dependent upon the purity of the two parent strains. Hybridizing is more extreme in its nature. It involves the crossing of distinct species, and has but limited application in agriculture.

Among the advantages attributed to the practice of crossbreeding are: faster growth, more efficient gains, increased vigor and increased fertility. The terms "heterosis" and "hybrid vigor" have been used to describe the increased vigor and efficiency of crossbred or hybrid individuals. The cause of the phenomenon of heterosis is difficult to explain. It may be pointed out, however, that crossbreeding is in contrast to inbreeding. The former tends to make for heterozygosity and the latter for homozygosity. Inbreeding limits the introduction of new factors and causes greater segregation with the result that recessive factors which are hidden in the heterozygous state are brought together and become homozygous. It has been suggested that recessive factors may sometimes be harmful to vigor, while dominant factors and heterozygosity may be correspondingly beneficial. Certain writers have pointed out that crossing gives added vigor because each parent furnishes some dominant factors lacking in the other. In the words of Watkins (*3*), "Hybrid vigor has never been accurately defined, but is one of these biological conceptions which is probably quite valid despite the difficulty of defining it."

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*Double Mated Litters*

In the light of divided opinion about the merits of crossbreeding, there has appeared a real need for carefully controlled trials. Animal experimentation is so fraught with disturbing influences that it is not sufficient to simply compare a single crossbred litter with a purebred litter when these are selected more or less at random. Two methods of experimentation appeared promising. One of these methods, which would involve a substantial number of breeding animals and cover a period of years, is outlined in this article. The other method, involving as it does double mated litters, would seek to permit accurate results using smaller numbers of breeding animals by the elimination of all possible variables and sources of errors. Crossbred and purebred pigs, carried in the same uterus, born the same day, experiencing the same conditions of temperature, nursing the same sow, and weaned at the same age and under the same conditions, should be particularly well suited for experimental purposes. A sow mated to two boars at the same period of oestrum has a reasonable chance of conceiving pigs to both sires. If, for example, a Tamworth sow is double mated to Tamworth and Yorkshire boars, the offspring from each sire can be identified by colours; the purebreds will be red and the crossbreds white.

One such double mated litter composed of ten pigs was farrowed by a Berkshire sow at the University of Saskatchewan in the spring of 1929. Six of the young pigs were obviously purebred Berkshires and four were crossbreds, Tamworth × Berkshire. At birth, the purebreds averaged 3.6 pounds, and the crossbreds, 3.7 pounds. At weaning age, the purebreds averaged 21.6 pounds and the crossbreds, 25.0 pounds. In the feeding trial which followed, the crossbred pigs demonstrated their superiority as feeders. They made an average daily gain of 1.35 pounds as compared with 1.06 pounds for the purebreds. The crossbred pigs made 100 pounds of gain on 311 pounds of grain consumed, while the purebreds required 377 pounds of grain to make the same increase in weight. The cost of producing 100 pounds of gain was $0.43 higher for the purebreds.

In the summer of 1930, a double-mated litter composed of three purebred Tamworths and three Yorkshire × Tamworth crossbreds was secured. At 180 days, the purebred pigs weighed 213.6 pounds and the crossbreds 238 pounds. The average daily gain for the purebreds was 1.36 pounds and for the crossbreds 1.56 pounds. The grain requirement per 100 pounds of gain was 278 pounds for the purebred group and 272 pounds for the crossbred group. The cost of producing 100 pounds of gain was $0.35 higher for the purebreds.

## THE EXPERIMENT

The breeding project which was planned to yield practical information about the five most common breeds and their crosses was started in the summer of 1929. Twenty gilts consisting of four Tamworths, four Yorkshires, four Poland Chinas, four Berkshires, and four Duroc-Jerseys were selected and assembled at the University of Saskatchewan. The gilts selected were typical of the most approved type of the respective breeds.

The breeding program covered a five-year period, and by using a boar of different breed each year, all the possible crosses were made and

each year's crop of pigs consisted of one group of purebreds and four groups of crossbreds. The boars were used in the following order:

| | |
|---|---|
| Tamworth boar used in the fall of | 1929 |
| Yorkshire boar used in the fall of | 1930 |
| Poland China boar used in the spring of | 1930 |
| Berkshire boar used in the fall of | 1931 |
| Duroc Jersey boar used in the fall of | 1932 |

The breeding program furnished five groups of purebred pigs and twenty groups of crossbred pigs. Data were gathered relative to birth weights, weaning weights, rapidity and economy of gains on feed and suitability of the finished pigs as indicated by market grades.

The experimental feeding periods did not begin for some one or two weeks after weaning. This interval was allowed so that the young pigs might become thoroughly adjusted to the ordinary feeds before the trials began. Feeding was conducted in as nearly a uniform manner as conditions over the five-year period would permit. The feeds used consisted of shorts, barley and recleaned screenings. The first named feed was used extensively at the beginning of each feeding trial. Buttermilk was used as a protein supplement. Pigs under 100 pounds received 1½ pounds of the milk per pound of grain fed, and pigs over 100 pounds received one pound of milk per pound of grain. Salt and a mineral mixture were provided and green forage was fed during the summer months.

The feeder pigs were kept in a well lighted piggery in separate pens with access to outside runs which provided for exercise, sunshine and an opportunity to root in the earth. The green forage which they received consisted of alfalfa freshly cut and brought to them daily. All pigs on feed were weighed at intervals of 28 days and turned off when they had attained optimum market weight.

*Gestation Periods and Birth Weights of Litters*

Former evidence (*1*) has suggested that crossbred pigs consistent with their alleged early-maturing qualities may be capable of quicker foetal development and shorter gestations. While there was no evidence to the contrary, the theory was not borne out by the small amount of data gleaned from the experiment. Neither was there any significant difference in the birth weights of crossbred and purebred pigs.

*Pigs Weights at Weaning Time*

It is sound to regard the weights of weanling pigs as an important indication of one or both of two characteristics, first the milking capacity of the sows, and the second, the inherent vigor of the young pigs. The rate of growth before weaning is more directly the result of natural qualities than the rate of growth after weaning when the pen-fed animals are being fed and reared under more artificial conditions.

The milking qualities of sows have frequently been overlooked by breeders. That breeds and strains of pigs vary as widely in milking potentialities as breeds and strains of cows has never been either proven or disproven, but there is evidence that variation is considerable. The Danish pig breeders have not been unmindful of the milking qualities of

the Landrace sows and this has undoubtedly been one reason for the retention of that breed.

The farmers of this country have frequently classified the Tamworth sows as first class mothers. Concrete evidence (*2*) gathered over a period of years would tend to substantiate this theory and it is interesting to note that, in the breeding project under discussion, the Tamworth sows brought the heaviest pigs to weaning age and were noticeably superior in this to the Yorkshire sows. The weaning weights of the pigs (purebred and crossbred) from sows of the five breeds studied are shown in Table 1. Weaning age was as constant as possible and all pigs were weaned at about 56 days.

TABLE 1.—WEIGHTS OF WEANLING PIGS

| Breeds of Dams | Number of litters | Number of pigs weaned | Total weight at weaning | Average weight at weaning |
|---|---|---|---|---|
| | | | lbs. | lbs. |
| Tamworth sows | 13 | 94 | 3,800 | 40.42 |
| Yorkshire sows | 13 | 104 | 3,593 | 34.55 |
| Poland China sows | 13 | 86 | 3,438 | 39.98 |
| Berkshire sows | 11 | 57 | 2,263 | 39.70 |
| Duroc Jersey sows | 14 | 102 | 3,889 | 38.13 |
| | 64 | 443 | 16,983 | Av.38.34 |

If it is true that rapidity of growth to the weaning stage is a more reliable indication of native and inherent vigor than development during the post weaning months, a comparison of purebred and crossbred pigs at weaning time should reveal some points of interest. In Table 2 it will

TABLE 2.—WEANING WEIGHTS OF PUREBRED AND CROSSBRED PIGS

| Breeding | Number weaned | Total weaned weight | Average weaning weight |
|---|---|---|---|
| Tamworth purebreds | 13 | 500 | 38.6 |
| Tamworth crossbreds | 163 | 5,892 | 36.1 |
| Yorkshire purebreds | 38 | 1,393 | 36.6 |
| Yorkshire crossbreds | 186 | 7,463 | 40.1 |
| Poland China purebreds | 15 | 447 | 29.8 |
| Poland China crossbreds | 125 | 4,944 | 39.5 |
| Berkshire purebreds | 12 | 422 | 35.1 |
| Berkshire crossbreds | 95 | 4,014 | 42.2 |
| Duroc Jersey purebreds | 13 | 488 | 37.5 |
| Duroc Jersey crossbredsl | 131 | 5,253 | 40.1 |
| All purebreds | | | 35 7 |
| All crossbreds | | | 39.38 |

be observed that the crossbred pigs outweighed the purebreds in all but one instance. In that one exception, purebred Tamworth pigs were heavier than crossbred Tamworth pigs at weaning, a fact not inconsistent with a former observation that Tamworth sows have demonstrated relatively heavy milking tendencies. The number of Tamworth crossbred pigs would include not only the crossbred pigs born to Tamworth sows, but also the pigs sired by the Tamworth boar and reared by sows of the other breeds. The greater weaning weight of purebred Tamworths might therefore be attributable to improved nourishment provided by the dams.

It is noteworthy that the average weaning weight for all purebreds was 35.7 pounds and for all crossbreds, 39.38 pounds. The difference between purebreds and crossbreds at birth was insignificant which would strongly suggest increased vigor and rapidity of growth for the crossbred sucklings.

*Feeding Qualities of the Purebreds and Crossbreds*

Over the five-year period, crossbred pigs in comparison with the purebreds were not only heavier at weaning time, but had a higher average daily gain while on feed. The average daily gain made by purebred pigs (Table 5) was 1.15 pounds and, for crossbreds, 1.24 pounds. Reference to Table 3 will show that when the purebred pigs of any single breed are compared with the crossbreds of which the breed considered is a parent, in three out of five times the crossbreds outgained the purebreds in a significant manner, and in the two remaining instances the average daily gains were the same for both purebreds and crossbreds. Considering the feeding trials one year at a time (Table 4), the purebred groups had the lowest daily gain in four out of the five years. It should be pointed out,

Table 3.—Feeding Record of Purebred and Crossbred Pigs

| Breeding | Number of pigs | Total gain on feed | Average daily gain | Grain per 100 lbs. gain | Milk per 100 lbs. gain | Grain equivalent of grain and milk per 100 lbs. gain (5 lbs. milk = 1 lb. grain) |
|---|---|---|---|---|---|---|
| Tamworth purebreds..... | 11 | 1,711 | 1.22 | 337 | 488 | 435 |
| Tamworth crossbreds..... | 154 | 22,566 | 1.22 | 357 | 485 | 454 |
| Yorkshire purebreds..... | 32 | 4,534 | 1.12 | 344 | 447 | 434 |
| Yorkshire crossbreds..... | 186 | 25,408 | 1.33 | 327 | 383 | 404 |
| Poland China purebreds... | 10 | 1,485 | 0.91 | 353 | 406 | 434 |
| Poland China crossbreds... | 108 | 14,542 | 1.23 | 343 | 390 | 421 |
| Berkshire purebreds..... | 11 | 1,315 | 1.24 | 382 | 403 | 463 |
| Berkshire crossbreds..... | 82 | 11,059 | 1.30 | 354 | 390 | 432 |
| Duroc Jersey purebreds.... | 13 | 2,103 | 1.34 | 367 | 365 | 440 |
| Duroc Jersey crossbreds... | 120 | 16,579 | 1.34 | 355 | 424 | 440 |

however, that the purebred Poland China pigs, which showed the lowest daily gains of all groups fed, were singular in several respects. Because of the necessity of completing the breeding program before the breeding efficiency of the sows was impaired, they were autumn-born pigs, whereas all of the other litters were born in the spring of the year.

TABLE 4.—DATA *re* FEEDING TRIALS

| Cross* | Season | Number of pigs on feed | Average daily gain | Grain per 100 lbs. gain | Buttermilk per 100 lbs. gain | Average Wt. corrected 200 days (±1.5 lbs. per day) |
|---|---|---|---|---|---|---|
| | | | lbs. | lbs. | lbs. | lbs. |
| Tamworth × Tamworth | Spring | 11 | 1.22 | 337 | 488 | 194.1 |
| Tamworth × Yorkshire | Spring | 24 | 1.20 | 331 | 528 | 210.0 |
| Tamworth × Poland China | Spring | 15 | 1.01 | 365 | 609 | 134.63 |
| Tamworth × Berkshire | Spring | 9 | 1.00 | 395 | 645 | 150.0 |
| Tamworth × Duroc Jersey | Spring | 30 | 1.24 | 385 | 607 | 182.5 |
| Yorkshire × Tamworth | Spring | 34 | 1.25 | 342 | 405 | 210.2 |
| Yorkshire × Yorkshire | Spring | 32 | 1.12 | 344 | 446 | 184.6 |
| Yorkshire × Poland China | Spring | 28 | 1.47 | 300 | 340 | 222.0 |
| Yorkshire × Berkshire | Spring | 21 | 1.30 | 303 | 357 | 212.5 |
| Yorkshire × Duroc Jersey | Spring | 31 | 1.40 | 313 | 360 | 217.0 |
| Poland × Tamworth | Fall | 14 | 1.24 | 358 | 322 | 200.5 |
| Poland × Yorkshire | Fall | 18 | 1.21 | 330 | 309 | 184.5 |
| Poland × Poland | Fall | 10 | 0.91 | 353 | 406 | 129.0 |
| Poland × Berkshire | Fall | 5 | 1.01 | 408 | 420 | 166.0 |
| Poland × Duroc Jersey | Fall | 12 | 1.00 | 396 | 417 | 178.0 |
| Berkshire × Tamworth | Spring | 12 | 1.42 | 337 | 352 | 222.0 |
| Berkshire × Yorkshire | Spring | 17 | 1.54 | 368 | 324 | 216.8 |
| Berkshire × Poland | Spring | 8 | 1.34 | 387 | 372 | 218.0 |
| Berkshire × Berkshire | Spring | 11 | 1.24 | 382 | 403 | 188.1 |
| Berkshire × Duroc Jersey | Spring | 5 | 1.40 | 382 | 357 | 226.7 |
| Duroc × Tamworth | Spring | 16 | 1.44 | 354 | 347 | 246.25 |
| Duroc × Yorkshire | Spring | 13 | 1.37 | 372 | 365 | 232.40 |
| Duroc × Poland | Spring | 8 | 1.45 | 325 | 336 | 256.10 |
| Duroc × Berkshire | Spring | 5 | 1.60 | 354 | 312 | 269.50 |
| Duroc × Duroc Jersey | Spring | 13 | 1.34 | 367 | 365 | 227.44 |

*The first named breed in each case was used as sire.

TABLE 5.—COMPARISON OF PUREBRED AND CROSSBRED PIGS IN THE FEEDING EXPERIMENTS

| Comparison | Purebred pigs | Crossbred pigs |
|---|---|---|
| Number of pigs fed | 77 | 325 |
| Total weight at beginning of feeding trials | 3,952 lbs. | 19,124 lbs. |
| Total weight at conclusion of feeding trials | 15,100 " | 64,201 " |
| Average weight at conclusion of feeding trials | 196.10 " | 197.54 " |
| Total gain in weight | 11,148 " | 45,077 " |
| Aggregate pig days on feed | 9,703 " | 36,550 " |
| Average daily gain | 1.15 " | 1.24 " |
| Total grain consumed | 39,372 " | 155,763 " |
| Total buttermilk consumed | 48,369 " | 188,477 " |
| Grain per 100 lbs. gain | 353 " | 345 " |
| Buttermilk per 100 lbs. gain | 433 " | 418 " |
| Grain equivalent of grain and buttermilk per 100 lbs. of gain | 440 " | 429 " |

The feed required to make a unit of gain was lower for the crossbred pigs. For 100 pounds of gain in weight (Table 5) the purebred pigs consumed 353 pounds of grain and 433 pounds of buttermilk, and the crossbreds 345 pounds of grain and 418 pounds of buttermilk. In one instance, as shown in Table 3, the purebred pigs out-scored the crossbreds in economy of gains. This concerned the purebred Tamworths and Tamworth crosses. In the case of purebred and crossbred Duroc Jerseys, the economy of gain was the same for each, and in the remaining three instances the crossbred pigs made more economical gains than the purebreds.

To further facilitate a comparison of the economy of gains in the purebred and crossbred pigs, the grain and buttermilk consumed were expressed in terms of grain equivalent per unit of gain. Admitting the obvious differences in the character of the feeds, it is a reasonable and convenient assumption that five pounds of buttermilk have about equal value with one pound of mixed grain. On this basis (Table 5) the crossbred pigs in the five-year experiment consumed 429 pounds of grain equivalent per 100 lbs. of gain in weight, and the purebreds cohsumed 440 pounds of grain equivalent per 100 lbs. gain.

The crossbred pigs had an advantage in the feed lot, but beyond that, it is hazardous to draw conclusions. Variations in feed requirements for the different breeds and crosses were so great that any except conservative conclusions would lack significance. When rate and economy of gains are considered, no one breed or cross demonstrated either marked superiority or inferiority. However, the more rapid and economical gains made by the crossbred pigs over the five-year period would seem to indicate that the practice of crossbreeding had much to commend it.

*Suitability for the Bacon Trade*

Only those breeds and crosses capable of producing pigs of a type acceptable on the Canadian and British markets need be considered by Canadian producers. The value of the farmers' pigs is so dependent upon correct type that the question of type is vital and must be considered along with rate and efficiency of gains. A complete record of market grades (Table 6) secured for the pigs marketed from the five-year breeding project reveals a marked and interesting variation. It is quite evident that the Yorkshire and Tamworth breeds rank high in comparison with the Berkshire, Duroc Jersey and Poland Chinas. If these data can be taken as representative, at least two of the breeds are unsuited for Canadian and British market requirements. The Poland China breed was the poorest when judged by bacon standards, both when bred pure and when used for crossing. An analysis of the record of market grades shows that the suitability of the breeds when judged by bacon standards would rank as follows: (1) Yorkshire, (2) Tamworth, (3) Duroc Jersey, (4) Berkshire, (5) Poland China.

The Yorkshire boar was the most effective in correcting faulty bacon type characteristics. It is too much to expect, however, that one cross of the bacon type on thick sows possessing round ribs and short sides will yield market tops. While the products of such a cross will represent vast improvement on the dams, they will lack the flat, even sides so desired by bacon curers, and it appears, therefore, that a good measure of the desired type is essential in the sows as well as the boars used if highly

acceptable bacon pigs are to be reared. Of the crosses studied, the Yorkshire × Tamworth and the Tamworth × Yorkshire were undoubtedly the best from a bacon standpoint. The boars used of the Duroc Jersey, Berkshire, and Poland China breeds were of the best available modern type, but it was noteworthy that a much larger percentage of their offspring (Table 6) were definitely lacking in bacon type, the majority being placed in the lower grades.

TABLE 6.—GRADING RECORD OF BREEDS AND CROSSES
(Canadian Market Grades Used)

| Cross | Number marketed | Grades | | |
|---|---|---|---|---|
| | | Select | Bacon | Butcher |
| Tamworth × Tamworth | 11 | 6 | 5 | – |
| Tamworth × Yorkshire | 24 | 16 | 8 | – |
| Tamworth × Poland China | 15 | – | 6 | 9 |
| Tamworth × Berkshire | 9 | – | 4 | 5 |
| Tamworth × Duroc Jersey | 30 | – | 15 | 15 |
| Yorkshire × Tamworth | 34 | 20 | 12 | 2 |
| Yorkshire × Yorskhire | 32 | 23 | 9 | – |
| Yorkshire × Poland China | 28 | 1 | 19 | 8 |
| Yorkshire × Berkshire | 21 | 7 | 9 | 5 |
| Yorkshire × Duroc Jersey | 31 | 10 | 14 | 7 |
| Poland China × Tamworth | 14 | – | 5 | 9 |
| Poland China × Yorkshire | 18 | – | 6 | 12 |
| Poland China × Poland China | 10 | – | – | 10 |
| Poland China × Berkshire | 5 | – | – | 5 |
| Poland China × Duroc Jersey | 12 | – | 1 | 11 |
| Berkshire × Tamworth | 12 | – | 4 | 8 |
| Berkshire × Yorkshire | 17 | – | 6 | 11 |
| Berkshire × Poland China | 8 | – | 5 | 3 |
| Berkshire × Berkshire | 11 | – | 3 | 8 |
| Berkshire × Duroc Jersey | 5 | – | 2 | 3 |
| Duroc Jersey × Tamworth | 16 | 2 | 6 | 8 |
| Duroc Jersey × Yorkshire | 13 | – | 12 | 1 |
| Duroc Jersey × Poland China | 8 | – | 4 | 4 |
| Duroc Jersey × Berkshire | 5 | – | 2 | 3 |
| Duroc Jersey × Duroc Jersey | 13 | – | 6 | 7 |

Colour is of considerable importance in the pig industry of the present day. Bacon curers prefer white pigs. While the Yorkshire was the only white breed of the five studied, it is a significant fact that white is a dominant hereditary characteristic in pigs. The practical significance of this fact is that a pure Yorkshire crossed with any other breed will, with few exceptions, yield white pigs. Black coat colour appears to be incompletely dominant to red and crosses involving these two colours frequently result in spotted pigs with black predominating. Reciprocal crosses display similar colours.

## DISCUSSION

If rapidity of gains can be taken as an indication of vigor, the crossbred pigs which have been studied could justly claim a larger measure than the purebreds. Seventy-seven purebred pigs showed an average daily

gain for the feeding periods of 1.15 pounds, and 325 crossbreds had the higher average of 1.24 pounds per day.

It does appear from this and many other experiments that there is a correlationship between rate and economy of gains. In this instance, the crossbred pigs utilized their feed more efficiently than the purebreds although the advantage was less pronounced than for rate of gains. The feed requirements of purebred and crossbred pigs per unit of gain compared as 440 to 429.

It is apparent that the crossbred pigs fed more efficiently than the purebreds, but it is extremely difficult to draw reliable conclusions about the merits of the breeds in feeding characteristics. The variations were wide and no one breed or cross was consistently superior or inferior, which lends weight to the theory that feeding efficiency is not entirely a question of breed. The best strains of all breeds studied may be expected to utilize feed with maximum efficiency, which means that the most useful breeds and crosses for bacon production must be selected on characteristics other than feeding qualities.

Granting the truth of the statement that crossbred pigs are easier feeders than purebred or ordinary grade pigs, the question to present itself is this, "Do crossbred pigs feed with sufficiently greater efficiency than purebred or grade pigs to compensate for the additional overhead and effort necessary when a cross-breeding program is pursued?" Cross-breeding as a general policy would not seem wise at the present time, but for those who are in a position to follow such a program and maintain the breeding herd with economical replacements, the practice of crossbreeding will ensure the production of feeder pigs capable of making not only rapid but economical gains.

The record of market grades is most significant and indicates the superiority of the Yorkshire and Tamworth purebreds and crossbreds for the production of suitable bacon carcasses, and the definite unsuitability of the other three. Of these three latter breeds, the Duroc Jersey appeared to cross to best advantage with the Yorkshire and Tamworths in producing pigs suitable for the bacon trade. Type within the breed is of prime importance to the producer of bacon pigs because of the fact that profit hinges largely on the market grade.

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(*Résumé sur page 336*)

# CREEPING YELLOW CRESS[1]

## A Weed in Process of Entrenchment

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[Received for publication December]

An ever-mounting influx of specimens of creeping yellow cress (*Rorippa sylvestris* (L.) Besser.) from widely separated regions in Canada, prompts the preparation of this note. The species is not by any means new to Canadian botanists, although newly introduced in many places, and still unfamiliar to the general public.

A specimen in the National Herbarium, Ottawa, collected by W. C. McCalla, from a roadside near Ball's Mills, Lincoln Co., Ont., June 10, 1897, is evidence that the weed has been in Canada from at least that time. It was found at Galt, Ont., in 1901. Although known now from Newfoundland (Robinson & Schrenk, 1894) to Vancouver, B.C. (Groh, 1931), reports are still most frequent from Ontario.

It is interesting to piece together what records are extant showing the trends of spread in North America. From Torrey and Gray's Flora of North America, Vol. I, published from 1838-1840, we learn that *Nasturtium* (including *Rorippa*) *sylvestre* R.Br. was present on the banks of the Delaware at Philadelphia, Pa., in 1838; and no other station seems to have been known at the time. By 1867, when the fifth edition of Gray's Manual appeared, the species was considered to be naturalized though rare, from Massachusetts, northward from the original station, to Virginia, southward. After another thirty years Britton and Brown's Illustrated Flora extended the range inland to Ohio. In 1933 Small's Manual of Southeastern Flora indicated a range from Virginia to Alabama and Louisiana in the south, and from Newfoundland to Illinois in the north. Evidently the Mississippi valley is about the western boundary of its occurrence. This may be true for the United States, but as already stated, the weed has gained a Canadian foothold on the Pacific coast, and it is present under irrigation at Windermere in the Columbia valley, but without perhaps establishing itself in the extensive drier territory of the plains.

There is probably ecological significance in the present distribution of yellow cress, in addition to the logical spread outward through time. Like most of its closest allies, it has a distinct preference for moister conditions than those obtaining in much of the present unoccupied range. The sporadic occurrence so far true of it, however, points even more strongly to the vagaries of chance opportunity as a large determinant.

From our records it is sufficiently shown that the movement of nursery stock has played a prominent part in establishing new colonies of this weed, both from within our borders, and from abroad. Such outside sources are largely European, although the plant is native also of northern Asia. The infestation most recently brought to our attention, in a nursery in the neighbourhood of Halifax, N.S., is attributed to nursery stock

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imported from Belgium. A small outbreak in the sod surrounding a young tree of *Populus Wilsoni* imported from Holland to the Experimental Farm Arboretum a few years ago, would appear to have come with the tree, although the roots were free of soil and of any sign of stowaway rubbish with the packing material. The merest fragment of root-stock is capable of budding, however, and might well have resisted any drying in transit which the tree roots would withstand.

While the progress made in North America may not seem to be very rapid, nor very alarming for one hundred years, it must be remembered that no real survey of its prevalence has yet been made. Such records as we stumble upon are widely distributed, and only require time to add to their density. The spread of yellow cress will not be so spectacular as that of perennial sow thistle with its wind-borne seeds, but if slower it will be no less sure. We have little information concerning its reproduction by seed, but know that in its underground propagation it is most efficient. Not only are the root organs perennial, but they are extensively creeping, slender and crisp, breaking up into small pieces difficult of removal from the soil, and each scattered fragment capable of budding profusely.

The stems of yellow cress are slender and when well-grown form a dense tangle. On the other hand, when prevented from developing, the plants can persist in sod by means of shoots so inconspicuous among the grass blades that they may easily be overlooked. The leaf blade is dissected to the midrib into five or six pairs of lobes. The flowers are small, in racemes, with yellow petals, and are followed by slender pods on pedicels nearly their own length, together about two centimeters long. The seeds are nearly round, orange-brown in colour, and less than a millimeter in diameter. Fig. 1. A.B.C.D.

More familiar to students of plant life in this country is the related marsh cress (*Rorippa* (*Radicula*) *palustris* Besser.) in one or other of its varieties, Figure 1. E.F.G.H., which are native and common in ditches and in saturated soil. They are more erect in habit, have leaves less deeply cut, and their small yellow flowers are succeeded by shorter pods. They are not perennial and only occasionally troublesome, and this when growing in soil in need of drainage. The typical European *R. palustris*, which has been found on Anticosti Island and sparingly in the east, is less stout and sometimes not unlike *R. sylvestris* in appearance. It was recorded in 1935 from Greenstreet, Sask., where Jas. L. Patmore found it evidently introduced in a few patches.

From the same locality, curiously enough, Mr. Patmore in 1932, had already been able to report another allied weed, Austrian field cress (*Rorippa austriaca Besser.*) Figure 1, J.K.L., until then unknown in Canada. It is distinguished by less deeply cut clasping upper leaves, by pods almost spherical with a prominent point, and by a strongly creeping root system.

Until experimental work has been carried out it is only possible to generalize regarding the control of creeping yellow cress. Seeding should be prevented. Patches while still of limited area should be dug over by hand for removal of pieces of rootstocks. When cultivation is being done with implements, caution must be observed to prevent scattering to clean land. Such cultivation can only be successful as it is made to deprive the plant continuously of foliage. It may be preferable in some cases to


FIGURE 1. *Rorippa sylvestris*. Yellow cress. A, part of plant showing habit; X 1/3. B, seed-pod; X 3. C, section of pod showing one row of seeds; X 4. D, seed; X 18. *Rorippa palustris* var. *glabrata*. Marsh cress. E, part of plant showing habit; X 1/3. F, seed-pod; X 3. G, section of pod showing two rows of seeds; X 4. *Rorippa palustris* var. *hispida*. Marsh cress. H, seed-pod; X 3. *Rorippa austriaca*. Austrian field cress. J, part of plant showing general habit; X 1/3. K, flower; X 3. L, seed-pod; X 3. (Owing to unintended magnification in reproduction, each numeral is to be multiplied by the factor 1.16 for correction.)

(From Weeds. W. C. Muenscher. The Macmillan Company. By courtesy of the publishers.)

starve the weed by keeping under mulch paper. Of chemical methods, spraying with sodium chlorate would seem to offer the best prospect of success; and if carried out with reasonable care, need involve little risk of fire, poisoning of animals, or injury to vegetation growing adjacent, or to follow after an interval of a few months or a season at most.

One other measure which might be desirable against some weeds of this type, and which has been long accepted as a matter of course against plant disease and insect pests, is inspection of importations from abroad, or actual embargo. In this instance it could only intercept fresh invasions of a weed already spreading from within with little hindrance. In other instances, or under certain circumstances, a greater degree of protection might be hoped for. Some years ago Turkestan alfalfa seed was coming into the country in some volume, and with it was coming Russian knapweed, until a virtual embargo was applied. For years it seemed as if, unlike many States to the south, we had escaped a menace; but since 1928 numerous infestations have been coming to light, especially in the prairie provinces, which probably antedate the closing of this channel of commerce. Even the best supported case for regulation would have to take into account biological and economic considerations; but that we are open to grave dangers at present is clear.

There is urgent need for more intensive weed survey activities than have yet been possible. Those provinces which require the appointment of weed inspectors in each municipality, have some means of guaging the weed situation, and detecting the advent of new weeds, but some of the provinces are still quiescent in the matter. In seed-growing districts the activities of the inspectors of the Dominion Seed Branch bring them into touch with local conditions. For the most part though, we are still dependent on chance for the discovery of the arrival and spread of potential weed pests. As rapidly as circumstances permit, something like a central clearing house of weed survey information is being provided in the Division of Botany, and a certain amount of field work is being done each year, but the active co-operation of hundreds of observers all over Canada, will be needed to make this the efficient agency which it might be for the prompt appraisal of any weed and the measures required to suppress it.

Having such information it will still, of course, be outside the province of any government service to carry out the extermination of endless outbreaks of weeds. Unless local interest, individual and community, takes hold and avails itself of the help proffered, it will matter little whether our records show a half-dozen or a hundred stations for yellow cress or another weed,—it will go on from a mere reproach which might be removed, to become in time a perpetual incubus of expense and trouble.

## BOOK REVIEW

VERNALIZATION AND PHASIC DEVELOPMENT OF PLANTS. Imperial Bureau of Plant Genetics: Plants Other than Herbage,—School of Agr., Cambridge England. Herbage Plants,—Welsh Plant Breeding Station, Aberystwyth, Wales. Price 10/-.

A new bulletin bearing the above title and summarizing the results of the many experiments that have been conducted in this particular field throughout the world has just been issued jointly by the Imperial Bureaux of Plant Genetics, Aberystwyth, Wales and Cambridge, England. This excellent review illustrates how admirably these Imperial Bureaux are fulfilling their function. As Sir David Chadwick says in his foreword: "Research workers need the earliest possible information on developments affecting their line of study but frequently find themselves baffled by its volume and by linguistic difficulties." The great majority of the articles dealt with are written in Russian and would have remained a closed book to most of the outside world had they not been made available in the present form. A total of over 200 separate articles on this revived and still controversial subject are reviewed in detail and in a most impartial and interesting manner.

The term "vernalization" is a latinized equivalent of the Russian word "Jarovizacija" coined by T. D. Lysenko, head of the Odessa School of Plant Physiologists and chief exponent of the principle involved. It represents a phenomenon which strictly speaking means the "transformation of winter forms into spring forms." If, for example, seeds of a winter wheat variety are germinated at low temperatures and subsequently subjected to proper conditions of humidity, light, aeration and other factors, they may be sown in the spring when they will develop as a spring variety. The theory is that growth is to be regarded as a phenomenon which is entirely separate from that of reproduction and that where one phemonenon is favoured and the other ignored the behaviour is likely to be *abnormal*.

This idea was first brought to the attention of English speaking readers by a bulletin issued in 1933 by the Imperial Bureau of Plant Genetics. This bulletin described the method in detail and created an immense interest throughout the world, especially among agronomists who were quick to detect the practical possibilities of such a scheme. Since that time the principle involved has been widely investigated and the resulting literature has become voluminous. This, as reviewed in the new bulletin, includes the results of many experiments both in the Soviet Union and in other lands. It records the outcome of vernalization as applied to over 6,000 varieties of wheat in Russia and the sowings of vernalized seed on over 12½ million acres. The findings in connection with these particular tests are of more than usual interest to Canadians.

While doubt is expressed by some investigators as to the probability of increased yields resulting from "vernalization" it appears to be conceded by the majority that this treatment may assume considerable importance when applied to crops where early maturity is sought. It is even believed by certain authors that the method as worked out by Lysenko is destined to prove of great importance in connection with the extension of the northern limits of grain cultivation. This view, however, has not the universal support of experimental evidence.

The practical value of vernalization in increasing drought resistance, frost resistance and winter hardiness as investigated by a number of workers is also reviewed quite fully, but here again there is a lack of agreement. The results obtained, however, lead one to conclude that an improved technique may make the method of greater value in some districts and when applied to some crops and varieties. To the plant breeder the present method should be of distinct interest in view, among other things, of the extent to which it may permit the more rapid increase of hybrid progenies.

The experimental investigation of vernalization in relation to forage plants has not reached the same stage of advancement as it has with cereal crops. Several perennial grasses and legumes, however, have been studied. Timothy, for example, showed a marked response to the temperature variant, while red clover was most affected by the duration of the chilling process. In both timothy and red clover, the phasic development was accelerated, seed being produced the first year. The acceleration in plant development was found to be proportionate to the perennialism of the species. Some after-effects of vernalization were apparent, chiefly in the second year, which resulted in a more uniform stage of flowering and a measurable increase in the forage yield.

In the vernalization experiments with certain annual crops such as maize and soybeans, negative results have usually been obtained. The water which was added to the seed in pre-treatment favoured molds, and the treatments lowered germinability. Those plants which were produced from viable seed after pre-treatment failed to show any acceleration in development. It is apparent that further experimental work is required with these crops, but if a method of pre-treatment should be devised which would give positive results it might prove very valuable in extending the northern limits for the successful culture of these crops.

Pre-treatment of the seeds of such crops as sugar beets and turnips has been found effective in inducing a high percentage of "bolting". This makes it possible to produce seed in a single season, whereas two seasons are normally required. In this way, the seed of a valuable strain can be rapidly increased, and it is also of importance that the roots which fail to "bolt" are not impaired in their feeding value.

From a theoretical standpoint the principles involved in "vernalization and phasic development" should be of interest to biochemists, plant physiologists and indeed to anyone concerned in modern trends within the field of agricultural research.

—L. H. Newman and L. E. Kirk.

## Résumé

**L'étude de certaines pratiques d'élevage dans la production porcine. A. M. Shaw et J. W. G. MacEwan, Université de Saskatchewan, Saskatoon, Sask.**

A Saskatoon on a suivi le système de "double accouplement" pour essayer de déterminer la capacité relative des porcs de race pure et de race croisée au point de vue de la production du bacon. Vingt truies ont été fécondées cinq années de suite, chacune d'elles était saillie à la même période d'accouplement par deux verrats de races différentes. Ces accouplements ont donné cinq groupes de porcs de race pure (77 sujets) et vingt groupes de race croisée (325 sujets). Dans les essais d'alimentation les porcs croisés ont fait une augmentation moyenne quotidienne de 1·24 livre contre 1·15 pour ceux de race pure. La nourriture exigée par unité d'augmentation de poids a été de 429 livres pour les porcs croisés et 440 livres pour ceux de race pure. Admettant que les sujets de race croisée s'engraissent plus facilement que ceux de race pure ou d'espèce ordinaire, la question suivante se pose:—"Cet avantage que présentent les porcs croisés au point de vue engraissement est-il suffisant pour dédommager du surcroît de frais et de peine que nécessite un programme de croisement". Il ne semble pas qu'il soit sage, dans les conditions actuelles de pratiquer le croisement comme système général, mais ceux qui peuvent le faire, et qui sont en mesure de maintenir le troupeau de reproduction économiquement, peuvent compter obtenir des porcs d'engrais capables de faire des gains rapides et économiques.

THE ECONOMIC ANNALIST

A REVIEW OF AGRICULTURAL BUSINESS PREPARED BI-MONTHLY BY THE AGRICULTURAL ECONOMICS BRANCH, DEPARTMENT OF AGRICULTURE, OTTAWA

Vol. VI, No. 1 February, 1936

## THE ECONOMIC SITUATION

PREPARED IN THE AGRICULTURAL ECONOMICS BRANCH, DEPARTMENT OF AGRICULTURE, OTTAWA, LARGELY FROM BASIC DATA COLLECTED BY THE DOMINION BUREAU OF STATISTICS

Wholesale prices fell fractionally in November and December, 1935, but remained close to the high level established in October. The year ended with the index 1.4 points above December, 1934. The course of wholesale prices during 1935 was subject to only minor fluctuations, with a slightly upward tendency throughout the year. The year-end decline took place mainly in the cases of vegetable products, animals and their products, and non-ferrous metals and their products. A gain of 0.7 was recorded by wood, wood products and paper over the October figure. Other changes were of minor importance. The decline in the index of animal products follows a sharp rise from August to October.

***Retail Prices.***—Retail prices continued to rise during November and December, reaching 80.8 for December. This is the highest point since September, 1932. The December, 1935, index was 1.8 points above that of the same month a year ago. The increase took place in the indexes of food and fuel, while those of rent, clothing and sundries remained constant.

***Physical Volume of Business.***—The index of the physical volume of business reached a high for the year in November at 110.0. This high level was not maintained during December however and the index at the close of the year was 106.2. This compares with an index of 92.4 for December, 1934. This index fluctuated a good deal throughout 1935 and the high level reached in November may be accounted for in part by the very marked increase in automobile production, the index of which rose from 60.2 in October to 115.2 in November. This rise was brought about by the early showing of the 1936 models. Mineral production was lower for November, but recovered again in December. Manufacturing reached a high for the year in November, at 118.5, but fell to 112.5 during December. The construction index fell sharply during the last two months of the year and closed below the level of December, 1934. The index of agricultural marketings reached a seasonal low in December and was 2.0 points below the same month of 1934. This decline was more pronounced in the case of grain marketings, although live stock marketings were also lower. Cold storage holdings increased during November and December, but were still below the 1934 levels for the same months.

***Prices of Agricultural Products.***—After reaching in October, 1935, the highest point in five years, the wholesale index of Canadian farm products receded slightly for November, but recovered partially in December. The November decline was evidenced in the index of prices for field products, while the index of animal products continued the rise which commenced in July, 1935. The December index of animal products reached the highest point since April, 1931. The 1935 average index for farm products was 63.4, the highest for any year since 1930. Steady improvement has been shown in this yearly figure since 1932. All classes of live stock recorded higher prices during December, with substantial gains reported in the prices of steers, calves, hogs and lambs.

ANNUAL AND MONTHLY INDEX NUMBERS OF PRICES AND PRODUCTION
COMPUTED BY DOMINION BUREAU OF STATISTICS

| Year | Wholesale Prices 1926 = 100 | | | | Retail prices and cost of services (5) | Production (6) 1926 = 100 | | | |
|---|---|---|---|---|---|---|---|---|---|
| | All commodities (1) | Farm products (2) | Field products (3) | Animal products (4) | | Physical volume of business | Industrial production | Agricultural marketings | Cold Storage holdings |
| 1913 | 64.0 | 62.6 | 56.4 | 77.0 | 65.4 | | | | |
| 1914 | 65.5 | 69.2 | 64.9 | 79.0 | 66.0 | | | | |
| 1915 | 70.4 | 77.7 | 76.9 | 79.2 | 67.3 | | | | |
| 1916 | 84.3 | 89.7 | 88.4 | 92.3 | 72.5 | | | | |
| 1917 | 114.3 | 130.0 | 134.3 | 119.6 | 85.6 | | | | |
| 1918 | 127.4 | 132.9 | 132.0 | 134.7 | 97.4 | | | | |
| 1919 | 134.0 | 145.5 | 142.4 | 152.5 | 107.2 | 71.3 | 65.5 | 48.1 | 47.1 |
| 1920 | 155.9 | 161.6 | 166.5 | 149.9 | 124.2 | 75.0 | 69.9 | 52.6 | 94.2 |
| 1921 | 110.0 | 102.8 | 100.3 | 108.5 | 109.2 | 66.5 | 60.4 | 65.2 | 86.4 |
| 1922 | 97.3 | 86.7 | 81.3 | 99.1 | 100.0 | 79.1 | 76.9 | 82.6 | 82.8 |
| 1923 | 98.0 | 79.8 | 73.3 | 95.1 | 100.0 | 85.5 | 83.8 | 91.4 | 87.6 |
| 1924 | 99.4 | 87.0 | 82.6 | 97.2 | 98.0 | 84.6 | 82.4 | 102.5 | 114.9 |
| 1925 | 102.6 | 100.4 | 98.1 | 105.7 | 99.3 | 90.9 | 89.7 | 97.2 | 108.6 |
| 1926 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 | 100.0 |
| 1927 | 97.7 | 102.1 | 99.9 | 105.7 | 98.4 | 106.1 | 105.6 | 103.6 | 110.0 |
| 1928 | 96.4 | 100.7 | 92.6 | 114.3 | 98.9 | 117.3 | 117.8 | 146.7 | 112.8 |
| 1929 | 95.6 | 100.8 | 93.8 | 112.5 | 99.9 | 125.5 | 127.4 | 101.1 | 109.6 |
| 1930 | 86.6 | 82.3 | 70.0 | 102.9 | 99.2 | 109.5 | 108.0 | 103.0 | 128.4 |
| 1931 | 72.2 | 56.3 | 43.6 | 77.6 | 89.6 | 93.5 | 90.4 | 99.0 | 125.7 |
| 1932 | 66.7 | 48.4 | 41.1 | 60.7 | 81.4 | 78.7 | 74.0 | 114.3 | 120.1 |
| 1933 | 67.1 | 51.0 | 45.8 | 59.7 | 77.7 | 79.7 | 76.8 | 105.1 | 115.4 |
| 1934 | 71.6 | 59.0 | 53.8 | 67.7 | 78.9 | 94.2 | 93.6 | 88.5 | 114.2 |
| 1935 | 72.1 | 63.4 | 57.1 | 73.9 | 79.3 | 102.4 | 103.3 | 87.4 | 128.4 |
| 1935 | | | | | | | | | |
| Jan. | 71.5 | 61.4 | 55.7 | 71.0 | 78.8 | 97.5 | 97.8 | 30.6 | 143.7 |
| Feb. | 71.9 | 62.0 | 55.7 | 72.6 | 78.9 | 100.6 | 101.1 | 62.2 | 141.2 |
| Mar. | 72.0 | 62.7 | 56.4 | 73.3 | 78.8 | 94.2 | 93.3 | 65.4 | 143.2 |
| Apr. | 72.5 | 64.7 | 59.8 | 72.9 | 78.6 | 98.3 | 97.7 | 91.8 | 135.8 |
| May | 72.3 | 64.1 | 58.0 | 74.4 | 78.6 | 103.2 | 104.4 | 86.3 | 123.2 |
| June | 71.5 | 61.4 | 55.1 | 72.0 | 78.8 | 99.2 | 99.7 | 106.1 | 125.0 |
| July | 71.5 | 61.5 | 55.7 | 71.1 | 78.8 | 103.0 | 104.0 | 164.7 | 114.8 |
| Aug. | 71.6 | 61.8 | 55.5 | 72.4 | 79.4 | 107.9 | 110.3 | 163.9 | 117.0 |
| Sept. | 72.3 | 64.7 | 58.3 | 76.5 | 79.6 | 101.9 | 102.5 | 114.2 | 117.2 |
| Oct. | 73.1 | 65.8 | 59.3 | 76.7 | 80.4 | 107.2 | 109.5 | 86.6 | 119.7 |
| Nov. | 72.7 | 65.0 | 57.8 | 77.1 | 80.6 | 110.0 | 113.5 | 43.3 | 127.1 |
| Dec. | 72.6 | 65.4 | 57.9 | 77.9 | 80.8 | 106.2 | 108.8 | 34.0 | 133.4 |

1. See Prices and Price Indexes 1913-1928, pp. 19-21, 270-289 and 1913-1934, p. 15.
2. Wholesale prices of Canadian products of farm origin only. See Prices and Price Indexes 1913-1934, p. 52, and Monthly Mimeographs 1934 and 1935.
3. Wholesale prices of grains, fruits and vegetables.
4. Wholesale prices of Animals and Animal Products.
5. Including foods, rents, fuel, clothing and sundries, See Prices and Price Indexes 1913-1928, pp. 181-185, 290-293. 1926 = 100.
Prices and Price Indexes 1913-1934, p. 117, and Monthly Mimeographs, 1934-1935.
6. Monthly Review of Business Statistics, p. 8, and Monthly Indexes of the Physical Volume of Business in Canada, supplement to the Monthly Review of Business Statistics, November, 1932.

***Trade Conditions.***—The total trade of Canada increased from $1,174 millions in 1934 to $1,293 millions in 1935. Of this increase $72 millions were in the form of exports and $37 millions in imports. The excess of commodity exports over imports in 1935 amounted to $192 millions. Agricultural products showed little change in the two years just passed. In 1935 imports of agricultural and vegetable products amounted to $109,689,841 compared with $109,201,542 for 1934. Exports of the same commodities were $229,821,600 in 1935 compared with $229,380,466 in 1934. Animals and animal products showed an increase of exports amounting to approximately $17 millions while imports increased $2.4 millions. Other important increases

in exports occurred in wood, wood products and paper, and minerals of all classes. After taking into consideration the trade in coin and bullion, the so-called favourable trade balance of Canada amounted to $297,351,899 for 1935, compared with $252,152,067 for 1934.

The proportion of Canada's trade with the countries of the British Empire, the United States, and other foreign countries remained practically constant throughout 1934 and 1935. On the import side of the balance 31.6% of the total came from within the British Empire; 56.8% from the United States and 11.6% from other countries. Exports to the United Kingdom accounted for 51.3% of the total; the United States took 34.1% of the total, and 14.6% went to other countries.

The movement of wheat in international trade remains at a low level. Total shipments of wheat and wheat flour for the first twenty-six weeks of the current crop year amounted to just over 245 million bushels according to Mr. Broomhall's figures. For the same period of 1934–35, the total was 264 million bushels. Canada's share of this trade has increased somewhat over the previous year. In 1934–35, average weekly shipments amounted to 10.2 million bushels, of which 3.4 million bushels were supplied by North America (mostly Canada). For the 1935-36 crop year, North America has shipped 3.9 million bushels weekly of a total weekly average figure of 9.4 million bushels. Exports of live stock, chiefly to the United States, continue to increase and prospects in this regard appear encouraging.

## BARLEY AND LIVE STOCK IN CANADA

H. R. Hare[1]

Barley is the greatest cereal crop in Canada from the standpoint of producing live stock feed units per acre. A study of the long time average yield of this crop computed on a total digestible nutrient basis reveals that no other crop in any province attains to the high standard set by this cereal. Table No. 1 shown below sets forth a comparison of barley, wheat, oats and rye yields expressed in this feed unit.

Table 1.—Comparative long time average yield of cereals in total digestible nutrients in Canada by provinces* †

| —— | Barley | Wheat | Oats | Rye |
|---|---|---|---|---|
| Canada | 100 | 89 | 81 | 78 |
| Prince Edward Island | 100 | 82 | 75 | — |
| Nova Scotia | 100 | 88 | 85 | 83 |
| New Brunswick | 100 | 87 | 71 | 85 |
| Quebec | 100 | 90 | 72 | 85 |
| Ontario | 100 | 96 | 63 | 67 |
| Manitoba | 100 | 86 | 84 | 78 |
| Saskatchewan | 100 | 91 | 87 | 84 |
| Alberta | 100 | 90 | 86 | 71 |
| British Columbia | 100 | 93 | 92 | 70 |

*Computed from data collected by the Dominion Bureau of Statistics.

†Digestible protein + digestible carbohydrates + fat × 2.25 = total digestible nutrients—Henry and Morrison Feeds and Feeding.

In four of the provinces, barley excells its nearest competitor by more than 10% and in some provinces surpasses oats and rye as a feed producer by 30% or more. In the three prairie provinces where in most years two-thirds or more of Canada's barley crop is produced and where the live stock feeding enterprise is steadily becoming more important this point is of considerable significance. Were feed value the only factor which influences the acreage seeded to barley in Canada, no doubt the acreage in succeeding years would tend to increase more rapidly than it has been.

[1] Assistant Economist, Economics Branch, Department of Agriculture, Ottawa.

One of the counter-balancing factors influencing farmers in planning their acreage to be seeded to barley is the cash return per acre. For the harvest years 1930 to 1934, the average cereal yields of the prairie provinces multiplied by the average farm prices show that wheat has exceeded other cereals in providing cash returns per acre as expressed in Tables 2 and 3.

TABLE 2.—AVERAGE CASH RETURNS PER ACRE OF CEREALS PRODUCED IN THE PRAIRIE PROVINCES 1930–1934
(Av. Yield × Av. Farm Price)*

| —— | Wheat | Oats | Barley | Rye |
|---|---|---|---|---|
| | $ | $ | $ | $ |
| Manitoba | 6.79 | 4.68 | 4.47 | 3.85 |
| Saskatchewan | 4.81 | 3.45 | 3.28 | 1.95 |
| Alberta | 7.22 | 5.68 | 5.29 | 2.23 |
| Prairie Provinces | 5.85 | 4.38 | 4.19 | 2.28 |

*Computed from data collected by the Dominion Bureau of Statistics.

In comparing Tables 1 and 3, one notes that wheat has had an advantage in providing cash returns per acre greater than barley's lead over wheat in producing live stock food value. The superiority which barley possesses over other cereals in producing additional live stock food value per acre will make an appeal to the cereal producer who is growing cereals for feed purposes on his own farm but will have little attraction to the farmer producing the cereal as a cash crop.

TABLE 3.—COMPARATIVE AVERAGE CASH RETURNS PER ACRE OF CEREALS IN THE PRAIRIE PROVINCES, 1930–1934*

| —— | Wheat | Oats | Barley | Rye |
|---|---|---|---|---|
| Manitoba | 100 | 69 | 66 | 57 |
| Saskatchewan | 100 | 72 | 68 | 41 |
| Alberta | 100 | 79 | 73 | 31 |
| Prairie Provinces | 100 | 75 | 72 | 39 |

*Computed from data collected by the Dominion Bureau of Statistics.

During the past few years hog numbers on farms have been dropping but present indications point to increased interest in hog feeding.[2] This activity will tend to change the attitude of cereal producers but one other factor which may have some influence in barley acreage will be the debt situation in the prairie provinces. Though debt adjustment legislation designed to provide relief in this connection has been successful in some measure, there no doubt will still be a tendency to direct attention to those farm enterprises from which early cash returns may be expected. These are factors which no doubt will influence future barley acreage. Undoubtedly it is to the economic advantage of Canada that barley be produced to relieve the pressure of wheat on grain markets and that it be fed to live stock. In this connection, it is of interest to analyse the disposition of Canada's barley crop, which is made possible by data from the records of the grain trade. These set forth the barley distribution on a percentage basis.

Table 4 shows that the disposition outlets account for barley volumes in each year which differ greatly when compared one with another. During the five-year period, a relatively high percentage has been "exported," "stored," and "fed on farms or otherwise used." Other outlet channels have for the most part accounted for lesser percentages. The percentage disposed of in some channels tends to be constant from year to year, while other disposition outlets show great annual variation.

[2] Agricultural Situation and Outlook, 1936.

TABLE 4.—DISTRIBUTION OF THE TOTAL AVAILABLE BARLEY SUPPLY OF CANADA IN PERCENTAGES*

| —— | 1930–31 | 1931–32 | 1932–33 | 1933–34 | 1934–35 |
|---|---|---|---|---|---|
| Exported | 11 | 13 | 6 | 2 | 19 |
| Milled for consumption | 1 | 1 | 1 | 1 | 1 |
| Malting and brewing | 2 | 4 | 5 | 7 | 7 |
| Seed | 4 | 7 | 7 | 9 | 10 |
| Stored | 17 | 7 | 12 | 14 | 9 |
| Lost in cleaning | 1 | 1 | 1 | 4 | 2 |
| Fed on farms or otherwise used | 64 | 67 | 68 | 63 | 52 |

*Computed from data compiled by the Dominion Bureau of Statistics.

This variation is due in a large measure to the great fluctuations in the total volume of barley available for distribution for the several years which has formed the base in calculating the percentage distribution. There has, however, been much change in the volume absorbed by some of the channels of distribution as revealed in Table 5.

TABLE 5.—RANGE OF VOLUME OF BARLEY IN CANADA DISTRIBUTED THROUGH THE DIFFERENT CHANNELS 1930–31 TO 1934–35*

| —— | High year | | Low year | | Range during 5-year period million bushels |
|---|---|---|---|---|---|
| | Year | Million bushels | Year | Million bushels | |
| Available for distribution | 1930–31 | 177.7 | 1934–35 | 80.4 | 97.3 |
| Exported | 1930-31 | 19.2 | 1933–34 | 1.7 | 17.5 |
| Milled for consumption | 1930–31 | 1.3 | 1934-35 | 0.7 | 0.6 |
| Malting and brewing | 1934–35 | 6.0 | 1930–31 | 3.0 | 3.0 |
| Retained for seed | 1934–35 | 7.7 | 1933–34 | 7.2 | 0.5 |
| Stored | 1930–31 | 29.5 | 1934–35 | 5.5 | 24.0 |
| Lost in cleaning | 1933–34 | 2.9 | 1932–33 | 0.8 | 2.1 |
| Fed on farms or otherwise used | 1930–31 | 116.9 | 1934–35 | 44.1 | 72.8 |

*Computed from data compiled by the Dominion Bureau of Statistics.

In the disposition of the Canadian barley crop, no outlet should be slighted. That portion disposed of for "Malting and brewing" deserves special mention because of the premium prices paid for this quality of barley and because of its consequent influence in improving barley quality generally. That volume designated as "Fed on farms or otherwise used" however is of extreme importance for two reasons:—(1) The volume of barley used in this channel is particularly large, exceeding that disposed of through all other channels combined; and (2) the volume of barley for available distribution from year to year is variable and dependent on vagaries beyond the farmer's control, and during the past 5 years greatly varying annual quantities of barley have been used as live stock feed. This disposition outlet has been the great shock absorber whereby the annual production variations have been equalized. Live stock production has not varied in ratio with Canadian barley yields and has been forced to rely on feed cereals generally rather than barley alone. Any progress toward levelling out the annual barley production yields in Canada will aid materially in the development of the interdependent live stock feeding industry.

## SOME FACTS CONCERNING LIFE INSURANCE IN SOUTH-WESTERN SASKATCHEWAN[1]

W. J. HANSEN[2]

During the summer months of 1935, the Farm Management Department of the University of Saskatchewan, Saskatoon, in co-operation with the Agricultural Economics Branch of the Department of Agriculture, Ottawa, conducted an economic survey of farms in the southwestern part of the Province of Saskatchewan in the Municipalities of Chaplin, No. 164; Glen Bain, No. 105; Gravelbourg, No. 104; Pinto Creek, No. 75; Shamrock, No. 134; Waverley, No. 44; and Wood River, No. 74.

The main purpose of the survey was to determine farmers' progress resulting from farming operations under the methods of land utilization which prevailed during the period of settlement. The areas included in the study had experienced successive years of drought accompanying which in many places was severe injury from soil drifting. In connection with this project, data were secured regarding past and present life insurance contracts undertaken by farm operators. The information on life insurance together with other data collected in these survey projects is now being analysed, but from preliminary examinations of the data on insurance which have been made the following summary is presented.

***Size of Sample.***—The number of farm management records secured during the course of the survey represents approximately 30% of the total number of farm operators in these municipalities. This large number of records can be considered representative of the whole area.

TABLE 1.—NUMBER OF FARM OPERATORS WITH LIFE INSURANCE CONTRACTS IN FORCE IN 1935

| Rural municipalities | Number of farm records obtained | Number of farm operators having insurance | Percentage of farm operators having insurance |
|---|---|---|---|
| 1. Chaplin | 115 | 23 | 20.0 |
| 2. Glen Bain | 136 | 25 | 18.4 |
| 3. Gravelbourg | 146 | 45 | 30.8 |
| 4. Pinto Creek | 21 | 5 | 23.8 |
| 5. Shamrock | 124 | 18 | 14.5 |
| 6. Waverley | 137 | 24 | 17.5 |
| 7. Wood River | 160 | 41 | 25.6 |
| Total | 839 | 181 | 21.6 |

At the present time only 21.6% of the farm operators in these municipalities are protected by life insurance (Table 1). The Municipality of Gravelbourg had the highest and Shamrock the lowest percentage of farm operators with life insurance.

TABLE 2.—TYPES OF LIFE INSURANCE PROTECTION NOW CARRIED BY FARM OPERATORS

| Type of policy | Number of policies | Percentage |
|---|---|---|
| 1. 20-pay life | 127 | 50.4 |
| 2. Club insurance | 42 | 16.7 |
| 3. Life | 40 | 15.9 |
| 4. 20-year endowment | 38 | 15.1 |
| 5. Other | 5 | 1.9 |
| Total in force | 252 | 100.0 |

[1] Preliminary statement, subject to revision and correction.
[2] Agricultural Assistant, Economics Branch, Department of Agriculture, Ottawa.

The distribution of life insurance protection now carried by farm operators is shown in Table 2 according to types of insurance. It will be noted that the percentage of 20-pay life policies is three times as large as any other type of insurance, and is the dominating type of insurance protection now held by farm operators. It is beyond the present scope of this article to discuss the relative merits of the various types of insurance protection so held by farm operators.

TABLE 3.—TOTAL NUMBER OF EACH TYPE OF INSURANCE CONTRACTED AND DROPPED DURING THE LIFE TIME OF FARM OPERATORS

| Type of policy | Number of policies contracted | | Number of policies discontinued | Percentage dropped in each type |
|---|---|---|---|---|
| | Number | Per cent | | |
| 1. 20-pay life | 480 | 57.4 | 347 | 72.3 |
| 2. 20-year endowment | 175 | 20.9 | 135 | 77.1 |
| 3. Life | 110 | 13.1 | 70 | 63.6 |
| 4. Club insurance | 53 | 6.3 | 11 | 20.8 |
| 5. Other types | 19 | 2.3 | 13 | 68.4 |
| Total | 837 | 100.0 | 576 | 68.8 |

In Table 3, the relative position of various types of life insurance over the whole period is shown. Of all life insurance contracted during the present life time of the farm operators, 68.8% has been discontinued. The relative rank of each type of insurance may be compared in Tables 2 and 3. It will be noted that 20-pay life and life policies occupy the same relative positions with respect to other types. The Club insurance has risen from fourth to second place and 20-year endowment policies have fallen from second to fourth place among the types of insurance now in force. The other types of insurance on which Tables 1 and 2 are based include the following: 15- and 30-year endowments; endowments at 40; 60; 65; 15-pay life; annuity at 65; Industrial and Accident.

TABLE 4.—AMOUNT OF LIFE INSURANCE CONTRACTED, PAID UP, IN FORCE, AND DROPPED BY FARM OPERATORS

| Rural municipality | Amount of life insurance protection contracted | Amount of life insurance paid up | Amount of life insurance contracts in force | Amount of life insurance contracts discontinued |
|---|---|---|---|---|
| | $ | $ | $ | $ |
| 1. Chaplin | 146,000 | — | 46,000 | 100,000 |
| 2. Glen Bain | 330,500 | 1,000 | 77,500 | 752,000 |
| 3. Gravelbourg | 501,150 | 5,000 | 157,150 | 339,000 |
| 4. Pinto Creek | 61,100 | — | 19,000 | 42,100 |
| 5. Shamrock | 221,550 | — | 74,500 | 147,050 |
| 6. Waverley | 242,500 | 1,000 | 60,500 | 181,000 |
| 7. Wood River | 414,870 | 4,000 | 118,700 | 292,170 |
| Total | 1,917,670 | 11,000 | 533,350 | 1,353,320 |
| Percentage | 100.0 | 0.6 | 28.8 | 70.6 |

In Table 4, it will be seen that the total amount of life insurance contracted by 837 policies amounted to $1,917,670; of this amount 70.6% has been dropped. Of the total amount of life insurance contracted only $11,000 or 0.6% of the whole is represented by paid up policies.

TABLE 5.—COMPARISON OF OWNERS AND RENTERS WITH RESPECT TO THE CARRYING OF LIFE INSURANCE PROTECTION

| Farm operators | Owners | | Renters | |
|---|---|---|---|---|
| | Number | Per cent | Number | Per cent |
| With insurance protection | 459 | 65.6 | 74 | 53.2 |
| Without insurance protection | 241 | 34.4 | 65 | 46.8 |
| Total | 700 | 100.0 | 139 | 100.0 |

In Table 5, a comparison of present owners and renters with regard to the percentage with and without life insurance protection is given. Life insurance is carried by a larger proportion of the owners than of the tenants.

***Life Insurance Protection of Owners and Tenants.***—These data were analysed in order to determine whether there had been any significant difference between the types of policies in force by owners and tenants. For both owners and tenants the "20 Payment Life" type was the principal type in force. The "20 Year Endowment" type ranked second for tenants and fourth for owners. The straight life type occupied second place in importance for owners and fifth place for tenants. For owners, "Life" and "Club" policies were of equal importance. "Life" policies were not very significant for tenants.

Tenants had in force 10% more of those types of insurance that may be classed as investment type, than had owners. Owners accounted for 90% of all policies in force.

TABLE 6.—TYPES OF LIFE INSURANCE POLICIES IN FORCE BY OWNERS AND TENANTS —1935

| Type of policy | Owners | | Tenants | |
|---|---|---|---|---|
| | Number of policies | Percentage of total | Number of policies | Percentage of total |
| 20 Pay Life | 115 | 50.8 | 12 | 46.1 |
| Club | 38 | 16.8 | 4 | 15.4 |
| Life | 38 | 16.8 | 2 | 7.7 |
| 20 Year Endowment | 33 | 14.6 | 5 | 19.2 |
| Other | 2 | 0.8 | 3 | 11.6 |
| Total | 226 | 100.0 | 26 | 100.0 |

TABLE 7.—CASH SURRENDER VALUE, AMOUNTS OWING AND EQUITIES OF LIFE INSURANCE POLICIES IN FORCE

| | Amount | Percentage of cash surrender value |
|---|---|---|
| | $ | |
| Cash surrender value, 1935 | 174,586 | — |
| Owing on policies in force: | 70,969 | 40.6 |
| Premiums in arrears, $56,085 | | |
| Borrowed on policies, $14,884 | | |
| Equity of policies in force | 103,617 | 59.4 |

In Table 7, the cash surrender value of policies in force has been shown. Against the cash surrender value there is shown the amounts owing against the policies for premiums in arrears and borrowings, which equalled 40.6% of the cash surrender value. The present equities remaining in the policies in force amounted to 59.4% of the cash surrender value.

TABLE 8.—AGES OF FARM OPERATORS AT TIME INSURANCE WAS DISCONTINUED

| Age group | Frequency | Percentage of farm operators falling in each group | Age group | Frequency | Percentage of farm operators falling in each group |
|---|---|---|---|---|---|
| 16–20 | 7 | 1.2 | 46–50 | 92 | 16.0 |
| 21–25 | 36 | 6.2 | 51–55 | 74 | 12.8 |
| 26–30 | 55 | 9.6 | 56–60 | 14 | 2.4 |
| 31–35 | 81 | 14.1 | 61–65 | 12 | 2.1 |
| 36–40 | 91 | 15.8 | | | |
| 41–45 | 114 | 19.8 | Total | 576 | 100.0 |

In Table 8, the farm operators who reported having discontinued insurance are shown in age groups together with the frequency distribution. It is significant that 53.0% of the farm operators having dropped insurance were over 40 years of age and 17% over 50. Apparently the difficulties attending their farming operations have been too great to permit them to continue the protection of life insurance when it is most needed.

***Reasons Given for Discontinuing Life Insurance Protection.***—Three principal reasons were given by farm operators for having dropped life insurance protection. The predominating reason, accounting for 85% of all policies dropped was that of being unable to meet premiums because of other pressing financial obligations and sheer inability to pay. Policies were also dropped by farm operators taking out the cash surrender value of the policies and by a combination of borrowing on insurance and unpaid premiums.

TABLE 9.—REASONS GIVEN BY FARM OPERATORS FOR DISCONTINUING LIFE INSURANCE PROTECTION

| Reason | Number of policies discontinued | Percentage discontinued of total |
|---|---|---|
| Inability ot meet premium | 492 | 85.5 |
| Drew out cash surrender value | 17 | 2.9 |
| Combination of borrowing on insurance and unpaid premiums | 67 | 11.6 |
| Totals | 576 | 100.0 |

More than 50% of the policies dropped were in force for a period of five years or less, and 13 % of the policies were in force for one year only. The highest percentage of policies were dropped after they had been in force three years and is accounted for by the fact that premiums must be paid for three years before policies have a cash surrender value. It is evident that on 9% of all policies, contracted, farm operators were unable to make more than the initial first premium payment.

TABLE 10.—NUMBER OF YEARS POLICIES IN FORCEHAVE BEEN CARRIED, AND NUMBER OF YEARS POLICIES WERE CARRIED BEFORE BEING DROPPED BY FARM OPERATORS

| Number of years policies were in force | | Number of policies discontinued | Number of policies in force in 1935 |
|---|---|---|---|
| Years | All policies | | |
| 1–5 | 341 | 295 | 46 |
| 6–10 | 224 | 168 | 56 |
| 11–15 | 132 | 71 | 61 |
| 16–20 | 107 | 34 | 73 |
| 21–25 | 13 | 3 | 10 |
| 26–30 | 4 | 1 | 3 |
| 31+ | 7 | 4 | 3 |
| Total | 828 | 576 | 252 |

At this point it should be mentioned that the great majority of farm operators knew little about such matters as extended insurance or other salient features in connection with their policies. Some farm operators did not remember the name of the insurance company with which they were insured. Most farm operators were certain about the amount of the premiums payable, but a good number were doubtful as to the type of policy which they had contracted.

***Life Insurance per Head of Population.***—The average amount of life insurance per head of population in southwestern Saskatchewan in 1935 was $196, or one-third of the average amount of life insurance per head for the whole of Canada.[3] The average value of life insurance per head of dependents of insured farm operators amounted to $375. Taking into consideration, however, the present cash surrender value of the policies, less the amounts against the policies for unpaid premiums and on account of loans, the value of the equity per dependent in 1935 amounted to $146. In connection with this calculation "Club" policies in force have not been included because they have no cash surrender value.

TABLE 11.—AMOUNT OF LIFE INSURANCE PROTECTION IN FORCE IN RURAL MUNICIPALITIES PER HEAD OF POPULATION AND DEPENDENTS—1935

| Rural Municipality | | Amount in force | Population | Amount of insurance per head of population | Number of dependents of insured | Amount of insurance per head of dependents |
|---|---|---|---|---|---|---|
| | | $ | No. | $ | No. | $ |
| Chaplain | No. 164 | 46,000 | 342 | 137 | 193 | 238 |
| Glen Bain | No. 105 | 77,500 | 513 | 151 | 342 | 226 |
| Gravelburg | No. 104 | 157,150 | 511 | 307 | 351 | 448 |
| Pinto Creek | No. 75 | 19,000 | 63 | 302 | 46 | 413 |
| Shamrock | No. 154 | 74,500 | 396 | 188 | 217 | 343 |
| Waverley | No. 44 | 60,500 | 424 | 143 | 244 | 248 |
| Wood River | No. 74 | 118,700 | 520 | 228 | 350 | 359 |
| Totals | | 553,350 | 2,769 | 196 | 1,743 | 375 |

The 252 policies in force in 1935 had a net equity of $103,617, averaging $572 per policy holder, or $411 per policy. Dependents of insured operators totalled 709. The net equity per dependent averaged $146.

[3] Canada Year Book, 1934–35.

# LAND UTILIZATION IN CARLETON AND VICTORIA COUNTIES, NEW BRUNSWICK

IAN MCARTHUR[1]

The counties of Carleton and Victoria in the Province of New Brunswick were selected in 1935 for the purpose of a general farm management and cost of production of potatoes survey by the Economics Branch in co-operation with the New Brunswick Department of Agriculture. These two counties are located in the west central section of the Province, bordering the State of Maine, and broken by the upper St. John river. The two counties comprise a total of over 2 million acres, of which 597,874 acres were designated as farm land in the Census of 1931. This represents a reduction in farm land of 31,098 acres since 1921. Large areas in the Province of New Brunswick are still under forest.

The two counties included in the survey have the highest percentage of improved farm land of any in the Province. In Carleton county, over 53% of the farm land was improved in 1931, while in Victoria, 38% was improved. The number of occupied farms has been declining slightly for the past twenty years, but the size of the farms increased from 133 acres in 1911 to 148.8 acres in 1931. Table 1 presents the figures for the last three census years pertaining to the utilization of farm lands in these two counties. Prior to 1911 the county of Victoria was joined with the present county of Madawasca, making a comparison of previous years impossible.

TABLE 1.—NUMBER OF FARMS AND UTILIZATION OF FARM LANDS PER FARM IN THE COUNTIES OF CARLETON AND VICTORIA, NEW BRUNSWICK. CENSUS DATA 1911, 1921 AND 1931

| —— | 1931 | 1921 | 1911 |
|---|---|---|---|
| Number of farms | 4017 | 4499 | 4728 |
| Total farm area | 148.8 | 137.2 | 133.0 |
| Improved Land | 72.4 | 66.8 | 62.4 |
| Field crops | 57.9 | 46.9 | 48.6 |
| Idle or fallow | 0.3 | 1.3 | 0.1 |
| Orchard | 0.4 | 0.4 | 0.4 |
| Pasture | 12.4 | 14.8 | 12.9 |
| Other | 1.4 | 3.4 | 0.4 |
| Unimproved Land | 76.4 | 70.4 | 70.6 |
| Woodland | 68.0 | 63.4 | 60.5 |
| Natural pasture | 5.0 | 3.8 | 7.7 |
| Waste | 3.4 | 3.2 | 2.4 |

***Improved and Unimproved Land.***—Slightly over 50% of the farm land of the counties remains unimproved, but the acreage of improved land per farm is increasing with the size of the farms. Woodland is the chief item of the unimproved portion, accounting for sixty-eight acres per farm. Of the improved land 57.9 acres were devoted to field crops in 1931.

The farms included in the farm management survey showed a considerably larger acreage than the average for the two counties. This difference may be attributed to the fact that in the survey only farms growing five or more acres of potatoes in 1934 were included. The farms were selected at random, with an effort to secure as representative a sample as possible of the farming in the area. However, as special emphasis was being placed on the potato enterprise, many farms had to be omitted. On these farms, 56.7% of the total area was improved land, as compared with 48.6% for the entire area. Comparison of land utilization between the farms included in the survey and for the counties as a whole is shown in Table 2.

[1] Field Assistant, Economics Branch, Department of Agriculture, Ottawa.

TABLE 2.—UTILIZATION OF FARM LANDS IN CARLETON AND VICTORIA COUNTIES, NEW BRUNSWICK, 1931, AND ON 199 FARMS INCLUDED IN THE FARM MANAGEMENT SURVEY, 1934–1935

| — | Carleton and Victoria Counties, Census 1931, 4,017 Farms | | Carleton and Victoria Counties, Survey 1934-35, 199 Farms | |
|---|---|---|---|---|
| | Acres | Per cent | Acres | Per cent |
| Total farm area | 148.8 | 100.0 | 190.5 | 100.0 |
| Improved Land | 72.4 | 48.6 | 108.2 | 56.7 |
| Field crops | 57.9 | 38.9 | 86.2 | 45.2 |
| Pasture | 12.4 | 8.3 | 22.0 | 11.5 |
| Other | 2.1 | 1.4 | — | — |
| Unimproved Land | 76.4 | 51.4 | 82.3 | 43.3 |
| Woodland | 68.0 | 45.7 | 75.7 | 39.7 |
| Natural pasture | 5.0 | 3.4 | — | — |
| Waste, yards | 3.4 | 2.3 | 6.6 | 3.6 |

***Field Crops.***—More than 64% of the area devoted to field crops was used in the production of hay and oats. While a considerable quantity of hay was sold for cash, the majority of the crop produced was used on the farms for feeding to live stock. The next crop in importance from the standpoint of acreage was potatoes, this crop being relied upon to provide the major part of the cash income on the farms included in the survey. It is interesting to note that the average acreage of potatoes per farm in the counties of Carleton and Victoria was higher than that for any other county in Canada, according to the 1931 Census. The neighbouring county of Aroostook, Maine, is one of the most highly specialized potato growing areas in the United States.

TABLE 3.—AREA OF FIELD CROPS PER FARM, CARLETON AND VICTORIA COUNTIES, NEW BRUNSWICK, 1931, AND ON 199 FARMS INCLUDED IN THE FARM MANAGEMENT SURVEY 1934–1935

| — | Carleton and Victoria Census 1931 | | Carleton and Victoria Survey 1934–35 | | |
|---|---|---|---|---|---|
| | Acres per farm | Per cent of total | Farms with crop | Acres per farm | Per cent of total |
| Spring wheat | 0.7 | 1.2 | 150 | 2.1 | 2.5 |
| Barley | 0.8 | 1.4 | 95 | 1.5 | 1.7 |
| Oats | 15.9 | 27.5 | 199 | 25.4 | 29.5 |
| Buckwheat | 2.4 | 4.1 | 95 | 2.6 | 3.0 |
| Hay | 32.0 | 55.3 | 199 | 39.3 | 45.6 |
| Potatoes | 5.8 | 10.0 | 199 | 13.8 | 16.0 |
| Other | 0.3 | 0.5 | 115 | 1.5 | 1.7 |
| Total | 57.9 | 100.0 | 199 | 86.2 | 100.0 |

A small acreage was devoted to spring wheat and buckwheat, chiefly for the purpose of supplying flour for household use. Barley was grown on less than 50% of the farms included in the survey and is not an important crop in the area. Other crops included peas, beans, fruits and vegetables.

The farm community in this section of New Brunswick ranks well up among the self sufficient farming areas of the Dominion.

***Crop History.***—Yields per acre of grains produced in New Brunswick were slightly higher for the ten year period, 1925–1934, than for the Dominion as a whole. The Dominion averages were lower because of adverse weather conditions on the Prairie Provinces. The average yield per acre of potatoes was 112.2 cwt., for New Brunswick, as compared with the Dominion average of 81.8 cwt. Climate and soil conditions in New Brunswick appear to be particularly suited to the production of potatoes. Yields of hay were slightly lower in New Brunswick. The yields per acre of grains do not show very wide fluctuations from the ten year averages, but for potatoes and hay the production per acre has been subject to wide variations.

TABLE 4.—YIELDS AND VALUES PER ACRE OF PRINCIPAL FIELD CROPS, CARLETON AND VICTORIA COUNTIES, NEW BRUNSWICK, 1925-1934

| Year | Wheat per acre | | Oats per acre | | Barley per acre | | Potatoes per acre | | Hay per acre | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Yield | Value | Yield | Value | Yield | Value | Yield | Value | Yield | Value |
| 1925 | 16.9 | 31.10 | 30.2 | 18.12 | 25.4 | 19.05 | 105.8 | 188.32 | 1.7 | 19.41 |
| 1926 | 16.5 | 29.37 | 25.0 | 17.75 | 20.8 | 19.14 | 142.5 | 188.10 | 1.5 | 16.12 |
| 1927 | 14.4 | 23.47 | 25.7 | 19.79 | 23.0 | 23.92 | 89.5 | 95.98 | 1.3 | 13.75 |
| 1928 | 17.8 | 29.55 | 30.3 | 21.21 | 27.6 | 28.15 | 129.7 | 45.40 | 1.4 | 14.95 |
| 1929 | 18.8 | 35.16 | 30.4 | 24.02 | 27.4 | 27.13 | 102.8 | 138.78 | 1.3 | 15.81 |
| 1930 | 18.8 | 18.80 | 32.5 | 13.00 | 29.7 | 17.82 | 121.9 | 79.24 | 1.5 | 16.72 |
| 1931 | 18.5 | 15.91 | 31.0 | 11.78 | 28.9 | 15.32 | 107.0 | 26.75 | 1.7 | 11.90 |
| 1932 | 17.7 | 15.58 | 31.3 | 10.33 | 27.7 | 14.68 | 80.0 | 40.0 | 1.6 | 11.84 |
| 1933 | 20.1 | 19.10 | 29.3 | 11.72 | 26.0 | 15.86 | 115.0 | 57.50 | 1.1 | 12.76 |
| 1934 | 20.4 | 20.40 | 30.6 | 13.16 | 27.2 | 16.32 | 128.0 | 42.24 | 1.1 | 14.96 |
| 10 yr. average | 18.0 | 24.30 | 29.3 | 16.12 | 26.4 | 20.06 | 112.2 | 90.88 | 1.4 | 14.48 |
| Dominion average | 16.2 | — | 28.6 | — | 22.4 | — | 81.8 | — | 1.5 | — |

The value per acre of the crops produced shows material changes from year to year. The values for all crops reached low levels for the period 1931 to 1934. This has been especially true of the potato crop. The value of potato production reached a low of $26.75 per acre in 1931, compared with a return of $188.32 per acre in 1925. Low prices for agricultural products from 1931 to 1934 have not of course been confined to New Brunswick. The value of the hay crop per acre improved considerably in 1934, following two successive short crops.

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The thirteenth annual report of the Alberta Wheat Pool records progress made during the financial year ending July 15, 1935. During the year the pool handled 30,890,721 bushels of grain or over 27 per cent of the total for the province. This was an increase of 3,800,277 bushels over the previous year. A voluntary pool was opened and 703,767 bushels—double the amount of the previous year—was handled on this basis. The total payment for pooled No. 1 Northern, basis Vancouver, was 77.719c. per bushel. The Pool operated 415 country elevators and terminals at Vancouver, Victoria and Prince Rupert. After full provision for depreciation on buildings and equipment, and after payment of interest on government indebtedness, there was a deficit from elevator operations of $47,788.40. However earnings of sundry reserves amounted to $107,700.47, and thus, the member equity was increased by $59,912.07. The report reviews the world wheat situation, weather conditions, production, wheat marketing legislation and activities in Canada.

## TERMINAL MARKETS[1]

W. C. HOPPER[2]

The interest which is now manifest in Canada and in the United States in the establishment of modern wholesale terminal markets in or near the cities is the result of a realization of the fact that revolutionary changes have taken place in the past decade and a half in the methods of getting perishable farm products from the farm to the city. It is also a recognition of the significant changes in merchandising policies and in consumer habits. Most of our city markets are out of date, and, as a consequence, the costs of getting the necessary farm products from the producer to the consumer are much too high.

Formerly, locally grown fruits, vegetables, poultry, eggs and other perishable farm products brought to the city by horses and wagons were sold almost entirely at retail to householders who carried home their purchases in baskets. While there is still a considerable volume sold at retail by producers direct to city consumers, the largest proportion of such farm commodities reach the city householder through retail agencies, which in turn must purchase their needs at wholesale from jobbers, truckers and producers.

Business growth, encroaching steadily on older residential sections of our cities, larger city populations, expanding city residential areas, more wide-spread knowledge of the value of fruits and vegetables in the diet, the private automobile, the chain store, the apartment house, and the desire on the part of the city families for greater services in connection with the obtaining of their food requirements have all been important influences which have been at work in changing consumer-buying practices and increasing the demand in our cities for fresh fruits and vegetables. In response to this increased demand, the supply of such products has been greatly enlarged, and the area devoted to the production of these commodities has been very much extended. Motor trucks have replaced horses as a means of getting these articles of food from the farm to the city.

Not only has the local supply been increased, but the year-round volume shipped in by rail from distant areas has also been greatly enlarged. The motor truck has made it possible for smaller centres of population to obtain, from the larger city markets, daily supplies of fruits, vegetables and other perishable farm products, and much of the produce which is received by rail and truck in the larger cities, such as Toronto and Montreal, is finally consumed in households many miles away from these cities.

***Inadequate Facilities.***—As a result of these new developments in production, transportation and marketing of farm products, we have arrived at a point where market distribution within a city is necessarily a complicated matter. The development of vehicles for transportation and the construction of highways leading to the cities have largely kept pace with the increased demand for farm products, but in the cities, very little has been done to improve the facilities for the transfer of these products from the increasing number of sellers to the many types of buyers. Marketing studies have always shown that a large proportion of the consumer's dollar goes to pay distribution costs and in the handling of perishable farm products it is in the cities that the greatest waste and maladjustments in market distribution occur. If the price-spread between producer and consumer is to be decreased, it is in the city that the greatest opportunity lies for doing so.

Public markets which were built to accommodate incoming products from nearby farms for the consumers of one city alone have in many cases become regional markets, and in some instances provincial and national markets, drawing produce from an extensive supply area to meet the demands of an ever-spreading region of demand.

Many of the existing market places which were constructed for horse traffic at a time when no one could foresee the great increase in city population which would take place, have become hopelessly inadequate to accommodate the vast increase in

[1] Paper read at the Annual Meeting of the Fruit Grower's Ass'n of Ontario and the Niagara Peninsula Fruit Growers' Ass'n, Hamilton, Ont., Feb. 14, 1936.

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the supply of farm products brought to them by motor trucks. The location of city markets has in many cases become quite unsuitable. When the city householders purchased their supplies direct from farmers, the market in the heart of the city was probably suitably located, but the growth of the city and the great increase in city traffic since the advent of the automobile and the motor truck has rendered markets in such locations uneconomical and inefficient. Not only is the space on many markets inadequate for the sellers, but proper parking facilities for buyers' vehicles cannot be provided except at a cost which would be enormous, and the purchase of adequate space in such a location would be wholly uneconomical. City market laws and market management have also become antiquated.

In many cities the carlot receivers are located at present at some distance from the railroad and must incur heavy and unnecessary handling costs because it is not possible to have direct rail connections to their places of business. The costs unnecessarily involved by growers, truckers and carlot receivers because of lack of proper market facilities must be borne by someone, and it is certain the growers contribute a substantial share.

As a consequence of the absence of suitable markets, a considerable proportion of the products required for city consumption may in some cities be sold direct to stores. This practice may require much of the grower's time which could be more profitably employed in the production of the products he has to sell. In the absence of a proper wholesale market growers cannot be as well informed as to what is the correct price for the commodities they have to offer to these retail agencies.

***Present Requirements.***—A terminal market should be so located that the produce can be transported to it at the lowest possible cost, that the market can be operated at a minimum expense to all concerned, and that it should be of such a size that there is adequate accommodation for those who sell as well as for those who wish to buy. It should be arranged and equipped for unloading, display and sale without loss of time, and for the rapid and economical transfer of farm products from the sellers to the buyers.

What is needed is a type of market centre which fits not only this description but which is properly managed to develop the whole project as a vital service to the consumers of the area. This latter point is especially important as it offers great possibilities in the way of better correlation of consumer demand with market supply through the adoption of regulations applying to weights and measures and to the grading of the products offered for sale.

With a market of this kind, the volume of farm products which may be disposed of should be enlarged, the costs of distribution should be substantially reduced, a price properly adjusted to the existing supply and demand conditions should prevail, and the producers should obtain a larger share of the consumer's dollar.

Without proper marketing facilities in our cities, demoralized market conditions are likely to prevail. Since the motor truck now brings to the city a large proportion of its requirements of perishable products, it is impossible to determine the daily volume of such food stuffs arriving in the city before trading begins. With truckloads of fruits, vegetables and other farm products arriving at all hours of the day and night, buyers become reluctant to purchase for fear that large supplies arriving at a later hour will break prices and involve them in losses. The absence of stabilized marketing conditions may, therefore, result in a restricted distribution of farmers' products. When well-located terminal markets of adequate size are provided, it should be possible to establish a satisfactory system of reporting arrivals and impending arrivals before the usual sales period opens for the day, and, with definite hours set for trading on the market, all the supply and all the demand will be concentrated and more equitable prices should be the result.

***Types of Terminal Markets.***—A number of different kinds of public market are in use in Canada and in the neighbouring states of the Union. There are markets where sales by growers and truckers are almost entirely in retail quantities; there are other markets where produce is sold at both retail and wholesale; and there are

still others where all or practically all of the produce is sold at wholesale. The wholesale, or terminal markets, may be divided into three types: first the market at which only commodities arriving by rail are sold; second, the market confined to the handling of produce arriving by motor truck; and, finally, the joint terminal market where both rail and truck-borne produce are offered for sale. Practically every city can support one or more retail markets, but it is the wholesale, or terminal, market that we are discussing today. The trend in the United States at the present time is towards the joint wholesale terminal market where facilities are provided for the exchange of produce brought to it by railroads and by motor trucks. The cities of Buffalo and Albany, N.Y., have new markets of this type and a new joint terminal market at Syracuse, N.Y., is now under construction.

It has been demonstrated that even for cities as large as Buffalo, only one terminal wholesale market can expect to succeed. If two such markets are constructed in the same city, one is doomed to almost certain failure. Millions of dollars have been lost in the ill advised construction of public markets in United States cities, and Canada might well benefit by the experiences of her neighbors. It has been found that buyers will go to the market where there is the largest supply and the most varied display of the products they desire to purchase. In the interests of low costs of city distribution, the farmer and trucker market should be in close proximity to the terminal for produce shipped in by rail, and in some cases consideration must also be given to boat shipments. In this connection let me quote from a report prepared in February, 1935, at the request of a committee made up of representatives of various divisions of the United States Federal Government. The report is entitled "Public Necessity Calls for Federal Aid in Modernizing Terminal Markets."

"Another aspect of what happens under the competitive system of building markets in cities and how difficult it is to create them is found in Buffalo. In 1925 and 1926 the city built two covered retail markets at a reported cost of $1,000,000. In 1930 the trade and two different railroads built separate combined-terminal-and-farmers' markets located about four miles apart at a total cost of $9,443,681. This, with the city's expenditure, made a total of $10,443,681. At the present time, the two city markets and one of the terminal markets are practically out of business.

"It appears that between six and seven million dollars might have been saved in Buffalo. From cost figures that we have on regional markets in New York State, this sum would in all probability have built the six regional markets and twenty-five secondary markets included in the original State Marketing Program proposed by the Department of Agriculture and Markets which included Buffalo."

***Comprehensive Studies are Essential.***—Before any definite action is taken to locate and build a market, it is wise, and perhaps I may say essential, to have a comprehensive study made of the whole market situation in and about the particular city concerned. Such a study would reveal necessary facts on the volume of produce coming to the city, the proportion brought by growers, truckers, railroads and boats, the areas from which it is transported, the volume consumed in the city, the amount which is shipped out again to other places and where these places are located, how the various retail agencies now obtain their supplies and the likelihood of retailers using a new terminal market, and a great deal of other information on the prevailing supply and demand conditions. The cost and suitability of various sites for the location of the market, the experience of other cities in solving their market problems, the best method of financing a market, and the most desirable method of operation and management are a few of the other problems on which information should be sought.

Experience in the United States indicates clearly that markets which have been started without proper consideration being given to these necessary facts have usually failed, with losses of large sums of money.

With the essential facts available, definite consideration can then be given to the matter of location, cost, size, layout, administration and financing of the new terminal market project.[3]

[3] The remainder of this paper will appear in the next issue of the Annalist.